FEBRUARY 1, 1918

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SPECIAL FEATURES

THE DESIGN OF AIR TURBINES
THE TECHNICAL HISTORY OF THE AIRPLANE
SEAPLANE FLOAT CONSTRUCTION
AERIAL TRANSPORT AND TRAVEL
INTERNATIONAL AIRCRAFT STANDARDS

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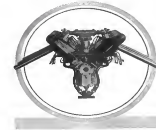

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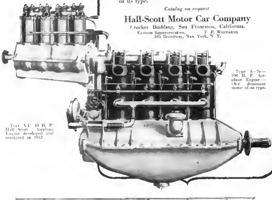

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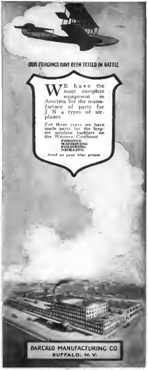
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Vol. IV February 1, 1918 No. 1

The Design of Air Turbines

By Alexander Klemin and Edward P. Warner

While air turbines have occasionally been used to pump gasoline from the main tank to an auxiliary, when it could feed by gravity, they were chosen for such purposes purely by a method of trial and error, and air turbine design did not really become important enough to warrant an attempt to establish it on scientific principles until the greatly extended use of radio apparatus, searchlights, stabilizer servo motors, etc., during the last few years, has made absolutely necessary the provision of satisfactory means, independent of the engine, for generating considerable quantities of electrical power.

Fig. 1

There are three methods of treating the design of air turbines, only two of which will be considered here. First, it may be based on experiment, reinforced by laws of geometrical similitude, which we shall discuss somewhat later. Second, it may be based on windmill theory. This is little used now for any purpose, the standard works on the subject are out of print and difficult to obtain, and we shall make no attempt at a treatment of it in this place. The third method, and the one which, in the opinion of the authors, gives by far the most satisfactory results, involves an application of the Drzewiecki, or Lanchester, theory of propeller design.

We shall now proceed to a discussion of the methods of designing air turbines in accordance with propeller theory, with incidental mention of the chief modifying factors, the effect of which is as yet undetermined, and shall then carry through the design of a representative fan. Methods of constructing will also be taken up.

If we draw a section through the blade at any point, it is apparent that the motion of that section is the resultant of two easily-defined components. One of these is parallel to the fan axis, and is equal to V, the speed of translation, while the other is perpendicular to that axis and is equal to $2\pi rn$. We may then write $\tan A = \frac{2\pi rn}{V}$, where A is the angle between the resultant motion and the axis of the fan. Since V and n are the same for all portions of the blade, we see that A diminishes as r diminishes.

We may now treat each infinitesimal element of the blade as a wing section, and calculate the forces accordingly. In order to secure forces of the magnitude which may prove to be desirable, each blade element is set at an angle B with the line of resultant motion of the element. (See Fig. 2.)

The results of a wind tunnel test on a wing section are primarily expressed by two graphs, giving, respectively, the force coefficients parallel and perpendicular to the wind direction. In applying such results to air turbine work, we desire to re-resolve these forces into components parallel and perpendicular to the axis, the first being the thrust on the bearings and the "effective resistance," which must be overcome by the propeller of the airplane, the second being the force due to the given element available for driving a generator.

Fig. 3 shows the axes in question, L and D being the forces on the element expressed in the conventional laboratory manner, T and Q those obtained by re-resolution.

It is immediately evident that:

$$T = L \sin A + D \cos A \quad (1)$$
$$Q = L \cos A - D \sin A \quad (2)$$
$$\text{Torque} = Qr = (L \cos A - D \sin A)r \quad (3)$$

$$\text{Let } \cot \gamma = \frac{L}{D}$$

$$\text{Then } \sin \gamma = \frac{D}{\sqrt{L^2 + D^2}}$$

$$\cos \gamma = \frac{L}{\sqrt{L^2 + D^2}}$$

Simplifying (1), we have $T = \sqrt{L^2 + D^2}(\cos \gamma \sin A + \sin \gamma \cos A) = \sqrt{L^2 + D^2} \times \sin (A + \gamma) = L \times \frac{\sin (A + \gamma)}{\cos \gamma}$.

$\cos \gamma$ differs from 1 by less than ½ per cent over the larger portion of the blade, and we may, therefore, write, without serious error $T = L \sin (A + \gamma)$

(3), similarly, reduces to Torque $= \sqrt{L^2 + D^2} \times r (\cos\gamma \cos A - \sin\gamma \sin A)$. Ignoring, as before, the small quantity $(\sqrt{L^2 + D^2} - L)$, we have Torque $= L \times r \times \cos(A + \gamma)$

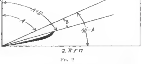


FIG. 2

The useful work done by the element is then: $P = 2\pi r n Q = 2\pi r n L \cos(A + \gamma)$, and the power which must be furnished at the airplane propeller to overcome its resistance is $R \times V \times L \times \sin(A + \gamma)$. The efficiency of the element is then $\dfrac{2\pi r n L \cos(A + \gamma)}{V L \sin(A + \gamma)} = \dfrac{\tan A}{\tan(A + \gamma)}$

the resultant velocity through the air, V_r^2 being equal to $V^2 + (2\pi r n)^2$. Having L, the torque and thrust per running foot at each point can be determined from the expressions $L \times r \times \cos(A + \gamma)$ and $L \times \sin(A + \gamma)$

The next step is to plot a torque grading curve and thrust grading curve, the abscissae of these curves representing the radial distance from the propeller axis to the station, their ordinates the torque and thrust per running foot, respectively. The areas under these curves then represent the torque and thrust for the entire blade, and furnish the data for computing the power developed and the resistance opposed by the turbine to the advance of the machine

Since the power required is ordinarily known in advance, it is customary to write the blade width at each station as a function of k, an unknown. We can then, after the completion of the graphical integration of the curves, solve for a value of k which will give exactly the necessary torque, thereby avoiding an application of cut-and-dry methods.

An alternative method of procedure is to draw curves of torque and $\dfrac{\text{torque}}{\text{efficiency}}$, the latter quantity being readily convertible into thrust

Having given this brief exposition of the method, we shall summarize the design of an actual air turbine. The assumed conditions are: a speed of translation of 65 m.p.h., a rotative speed of 3600 r.p.m., and a required power of 825 watts. We shall try at six bladed fan 14 in. in diameter. A table may then be drawn up as follows:

Station No	Rad. (ins.)	$2\pi rn$	A	Blade width	$(2\pi rn)^2$	$V_r^2 = V^2 + (2\pi rn)^2$	Angle B (in degrees)
1	6	188.5	63°15'	.93 k	35500	44400	6°
2	5	157.1	56°30'	k	24600	33600	6°
3	3½	110.0	48°10'	.98 k	12100	21100	6°
4	2	62.8	33°30'	.92 k	3940	[illegible]	6°

In attacking the actual design of an air turbine, we first decide on a diameter and blade form to be employed. Considerable latitude in these points is permissible, and it is generally possible, after a little experience, to guess them closely enough at the first trial. Several stations, from four to eight in number, are then placed at approximately equal intervals along the blade, and the section to be used at each is selected. These

We shall use Eiffel's propeller sections Nos. 61, 60, 59 and 31 for the four elements. These sections, due to the considerable camber of the lower face, give a large lift coefficient, thereby making it easy to secure the required power with the relatively small diameter proposed. From the experimental data given for these sections, we find K_y and K_x at 6°, continuing our table as below

Station No	K	$R = \dfrac{K \cdot b \cdot V_r^2}{144}$	$\dfrac{L}{D} = \cot\gamma$	γ	$Q = R \times \dfrac{r}{12} \times \cos(A+\gamma)$	$T = R \sin(A+\gamma)$
1	.00112	.340 k	12.3	4°40'	.064 k	.313 k
2	.00114	.266 k	10.4	[illegible]	.048 k	.240 k
3	.00120	.172 k	9.2	6°	.028 k	.141 k
4	.00090	.075 k	8.9	[illegible]	.009 k	.061 k

sections should be of such a nature as to give at least a fairly high L/D, and should resemble each other in general outline, although becoming thicker as the hub is approached

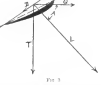


FIG. 3

The lift per running foot and the efficiency at each station are then determined, the lift being $K_y b V_r^2$, where K_y is the lift coefficient from a laboratory test, b the width of blade, and V_r

K, Q and T, in the above, are expressed as lbs. (or lbs. ft.) per running in. of blade, and k is the maximum blade width in ins.

We now plot curves of Q and T in Fig. 4. The former only

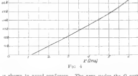


FIG. 4

is shown to avoid confusion. The area under the Q curve is found to be 43.2 squares, corresponding to a torque of .216 k lbs. ft., and the area under the T curve corresponds to a thrust of 1.05 k lbs.

It is desired to generate, as previously specified, 825 watts, and this is equal to 609 ft. lbs. per sec. Then, $2\pi Q n = 609$,

and $Q = 1.613$ lbs. ft., n being 60 revs. per sec. Dividing the total torque required by the number of blades, we see that the torque due to each blade must be 0.269 lbs. ft. Since the graphical integration just performed shows us that this torque is equal to 0.215 k lbs. ft., we may equate the two expressions, and k is then 1.25 ins. The width of each blade element may then be obtained by substituting this value for k in the column of the design computations.

Substituting for k in the expression for thrust, and multiplying by the number of blades, we find that the presence of the air turbine adds 7.9 lbs. to the total head resistance of the air turbine. The work done in driving it through the air is then equal to the resistance times the speed, or 750 ft. lbs. per sec., and the efficiency is 81 per cent.

Since, however, the power driving the turbine ahead must

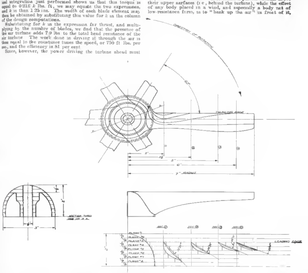


FIG. 5

first be transmitted through the propeller, and since the efficiency of the propeller is likely to be about 75 per cent, the overall efficiency of the air turbine as a generating device is equal to the product of these two quantities, or, roughly, 60 per cent. Although this appears rather low, the power consumed is so small in comparison with the total power of the engine that the slight loss is more than compensated for by having the generator function at all times, whether or not the engine is running, and by the avoidance of additional trains of gears driven by the crankshaft.

A drawing of this turbine is shown in Fig. 5, and a photograph in Fig. 1. The sections and contours are faired in the same way as for an air propeller, although less care is needed than in propeller drawing, and it will not be necessary to treat the method of layout.

Until the performance of further experimental work, it is almost impossible to say anything definite about the effects of interference due to objects close behind the fan. Since the effect of the blade elements is to create a partial vacuum above their upper surfaces (i.e., behind the turbine), while the effect of any body placed in a wind, and especially a body not of low-resistance form, is to "bank up the air" in front of it, creating a positive pressure, it is evident that these two tendencies will oppose each other, and that there will be some loss of power and efficiency as a result, but a quantitative determination of these losses by analytical methods would be a hopeless task.

The nature of the flow about the blades of an air turbine has not been fully determined. Since work is done by the system, energy must be withdrawn from the air, and it is probable that there is a certain diminution of speed of the air approaching the turbine before it actually impinges on the blades—a phenomenon analogous to the indraught of an air propeller.

If it be desired to find the work done and efficiency under other conditions, when the speed of rotation, or the speed of advance, or both, are varied, the procedure is that already carried out, save that the angle $(A + B)$ has now been fixed, and

B must, therefore, be obtained by subtraction, instead of being arbitrarily chosen. If the speed of rotation be increased, A will increase, and B will consequently decrease. The lift coefficient will become smaller, but the resultant velocity of each element will increase, and the counteraction of these two factors will result in giving a torque curve having a maximum at a comparatively low rate of rotation. The maximum useful work will occur at a considerably higher speed, as this quantity for equal torques is directly proportional to the rotational velocity, and the maximum efficiency will correspond to a still higher value. (See Fig. 6.)

An increase in the speed of advance, on the other hand,

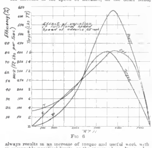


Fig. 6

always results in an increase of torque and useful work within reasonable practical limits, as the increased resultant velocity and increased angle of incidence B here work together, instead of opposing each other. The efficiency curve, however, has a maximum at a moderate speed, beyond which point it begins to drop off with increasing speed of advance. (See Fig. 7.)

An inspection of Fig. 6 shows that if the air turbine be so designed as to give nearly the maximum torque available for one of that size when operating under normal conditions, the torque curve in that vicinity will be very nearly horizontal, and a slight variation in torque will bring about a large change in speed. The regulation of the generator is therefore likely to be bad, and the apparatus may show itself prone to "hunt." This may be largely avoided, and without any serious loss of efficiency, if the elements be arranged to work at a smaller angle of incidence, so that normal conditions will correspond to a point on the negatively-sloping portion of the torque curve.

Turbines may be tested in a wind tunnel while actually driving a generator, and the torque, thrust, work and efficiency at various wind and rotational speeds may be actually determined. The work of this sort done thus far is scanty and unsatisfactory, but what there is of it seems to indicate a good accord between theoretical and actual results.

At the beginning of this paper it was remarked that empirical results may be extended to other similar cases by the direct application of simple formulae, and we shall now discuss this method of procedure. It is evident that, for geometrically similar turbines operating at the same rotational speed, and at speeds of advance directly proportional to the diameter, the torque is proportional to the fifth power of the diameter, since the blade area varies as the square of a linear dimension, and the resultant velocity of the element along its path, to the square of which the air force is proportional, varies directly as the diameter. It follows that the useful work done is proportional to the fifth power of the diameter, and that the efficiency remains unaffected.

For the more common case in which speed of advance remains constant and the rotational speed is inversely proportional to the diameter, the torque rises with the square of the diameter. When neither speed changes strict similarity cannot be maintained, but it will be found that the torque varies very nearly as the fourth power of the diameter. If small changes in power be desired they can be secured by a modification of the blade width, to which the work done is very nearly proportional.

It can readily be demonstrated, by differentiating the expression for efficiency with respect to γ, that the efficiency of any given element at a fixed angle of attack is a maximum

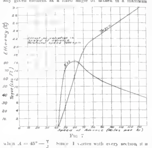


Fig. 7

when $A = 45° - \frac{\gamma}{2}$. Since γ varies with every section, it is necessary to adopt a compromise position for the point of greatest efficiency, and this position should be roughly coincident with the centroid of the torque grading curve, or about $\frac{3}{4}$ of the way out from the hub to the tip of the blade. In the case of the turbine, which we have been through the computations for, A is too large for best results, and a higher efficiency would have been secured if it had been possible to run at a somewhat lower speed (2200 r.p.m. for the very best results).

The constructors of air turbines are divided into two schools, using, respectively, wood and metal. The first method calls for no especial comment, being a direct adaptation from propeller construction. Laminations are sawed out from thin sheets of some suitable wood (usually mahogany or walnut) and glued together, and the blades are then finished by hand until they check properly with their templates.

The metal employed for the second class is some aluminum alloy, different manufacturers and foundries using different formulae. Turbines may be cast in sand molds from a wooden pattern in the usual fashion. This, however, entails the serious disadvantage that it is almost impossible to get the blades identical and set at the same angle, especially in four- or six-bladed patterns, without a prohibitive expenditure of time and the employment of pattern-makers of an exceptionally high order of skill.

A more satisfactory method, which seems to give uniformly good results, is the making of a wooden pattern for a single blade, and as large a wedge of the hub as naturally pertains thereto. From this pattern are made as many castings as the turbine has blades, and the various parts, after being carefully finished and gaged, are screwed or soldered together. This subsidiary metal pattern is made of brass or iron.

Propeller casting is a tricky task at best, and only the most expert of molders are able to withdraw the pattern and smooth down the sand in such a fashion that the casting will not be unduly liable to flaws, and will be a close reproduction of the original.

The Technical History of the Airplane*

By Capt. F. M. Green, A.F.Ae.S., A.M.I.C.E.

The history and development of mechanical flight may be confined almost entirely to the present century. In the last century some success had been achieved in gliding flight, model airplanes had been made and flown, and at least two man-carrying airplanes had actually left the ground, but it was not until the year 1903 that the Wright Bros., having ended a painstaking research in gliding flight, earned for themselves the honor of being the first men to fly.

Directly the success of the Wright Bros. became known, or rather when people began to believe that what the Wright Bros. claimed was actually true, the development of flying became rapid in the extreme. To-day one is tempted to wonder why it was that it had taken man so many centuries of civilization to do what now seems to most of us rather an ordinary thing. We can call to mind nothing in the nature of an invention, nothing new in first principles. We hear of flights from Turin to London, of airplanes that carry loads that are measured in tons, we know that flying is common at heights of four miles or more, where the air is less than half its usual density. When we hear of these things it seems as unbelievable to us now that until fifteen years ago no one had flown for half a mile carrying just his own weight as it seemed unbelievable to us fifteen years ago that we should ever fly at all.

The chief reason why the development has been so rapid is undoubtedly that, until an airplane had been made to fly at all, experimenting on full scale was impossible. It reminds us of the advice of the old lady to her grandson, "Don't go near the water until you have learned to swim." Directly mechanical flight was possible, full scale experiments were carried out, often at the risk of the life of the experimenter, and the more obvious problems became apparent. All the skill of the engineer and all the resources of science were called in to solve the problems as they occurred, until in the short space of fourteen years our scientific knowledge of aeronautics compares very favorably with the world-old science of navigation of the sea.

It is the intention of this paper to discuss the progress that has been made in dynamic flight, and to consider the chief factors that have made this progress possible. An attempt will be made to state in a general way the standard of development as it exists to-day, and to consider the possible direction of progress in the future.

Types of Machines

The flying machine is an apparatus in which an arrangement of surfaces is moved in such a way that the reaction of the air provides a vertical component of the force on the surfaces equal to the weight of the apparatus. An airplane, as we know it, has its supporting surfaces fixed relative to itself and is driven forward by the reaction of one or more airscrews.

Besides an airplane, two other sorts of flying machines have offered possibilities to the inventor. One is known as the Helicopter, in which the lifting surfaces are revolved in a horizontal plane. The second is called an Ornithopter, and in this the supporting surfaces are moved in a way to imitate a bird flapping its wings. Although both these types are conceivably possible, their usefulness and practicability appear doubtful, and it is only proposed in this paper to consider the airplane as we know it.

Airplane Performance

At the beginning of flying, the mere fact that an airplane left the ground at all was considered sufficient proof of its excellence. Nowadays we make careful measurements of the characteristics of each new airplane at various heights, and the word "performance" is used to refer to the speed, rate of climb, and load carried. A good performance is one of the important essentials of usefulness of an airplane, and we will now consider the factors that have enabled us to improve so much on the early airplanes.

There are four main factors that govern the performance of an airplane. They are:

1. The wing surface that supports the weight.
2. The total weight supported in flight.
3. The resistance of the airplane to forward motion.
4. The thrust available from the airscrew or airscrews.

These factors are very intimately connected, and each in turn will be considered, its effects discussed, and the possibility of improvement outlined.

Supporting Surface

Considering the first factor, the wings, it is necessary to know how to express the value of any particular arrangement of surfaces. The result at which to aim is to obtain the maximum vertical reaction or lift for the minimum horizontal reaction or drag. The term lift drag ratio is, therefore, a measure of the effectiveness of a plane. Another attribute is, however, desirable, viz., that the lift per square foot of plane shall be high, so that as little surface as possible need be used for a given minimum speed of flight.

Planes vary in curve, plan form, and arrangement and number of surfaces. The designer will vary these factors according to the sort of airplane he wishes to make.

Wing Section

The Wright Bros. did not know if they would be able to fly at all. They chose deeply cambered wing sections so that the maximum lift could be obtained at the minimum speed. The lift drag ratio of their planes was probably about 12 to 1, very much better than still earlier experimenters could obtain with flat planes. Present-day wing sections enable us to get a lift drag ratio of 17 to 18, while model tests have shown as good a ratio as 23.

This has been done at some sacrifice of maximum lift coefficient, that is to say, for a given minimum speed we need more surface to support a given weight than with a more cambered plane with a worse lift drag ratio. It would be an advantage if we could vary the camber of a plane to suit the speed, and many attempts to do this on an airplane in flight have been made. Unfortunately, apart from increased complication, the increased weight is likely to cause greater loss than gain.

Shortly before the war an experimental airplane was made at the Royal Aircraft Factory, which was fitted with wing flaps nearly the whole length of the plane. These flaps could either be turned down for low speed, or up for high speed, or they could be used differentially for balancing. It was in fact rather a crude way of varying camber. Although it achieved the distinction of being possibly the fastest airplane of the day, it was eventually considered that the extra weight and complication did not justify the device.

From many considerations it appears that much improvement in lift drag ratio is unlikely, but when the speed of airplanes becomes very much greater than it is to-day, it is quite possible that some device for changing the section of a plane during flight will be found necessary to obtain a reasonably slow landing speed.

Plan Form

Planes are generally made nearly rectangular in plan but with the ends more or less rounded. The ratio of span to chord is called aspect ratio and the higher this is made the better will be the lift drag ratio. Here again it is necessary to compromise, as the bigger the span of the airplane the heavier will be the wings, the greater the resistance of the necessary bracing and the rapidity of the manoeuvring of the whole airplane will be decreased. From practical consideration, therefore, the aspect ratio of an airplane is generally from 5 to 8; recently some large airplanes have gone considerably beyond this figure, but it is very doubtful if anything has been gained.

Little is known as to the effect of using planes other than roughly rectangular, but it is not very likely that much improvement will be found with planes of other shapes.

Arrangement of Surfaces

The original airplane of the Wright Bros. was a biplane, consisting of two planes separated by about the width of the chord. Shortly after, monoplanes, triplanes and quadruplanes were made and flown. It is fairly certain that the most efficient plane is the monoplane, for there is no possibility of interference of the planes as there is on the multiplane. A bi-

* Paper read before the Aeronautical Society of Great Britain.

plane, however, is probably only a little worse than the monoplane, while a triplane is a little worse than a biplane, and so on. Structurally, the biplane is very much easier to make than the monoplane and, owing to this, the biplane construction has been almost universally adopted. Triplanes and quadruplanes have not had very much success, although it is quite possible that for very large airplanes the advantages gained in construction may outweigh the disadvantages of their somewhat low effectiveness.

From time to time suggestions have also been made that the amount of wing surfaces should be varied. This again is a complicated thing to do, and with modern wing sections there is practically never any gain in reducing wing surfaces; in fact, most airplanes would fly faster and not slower by having more surface if such surface could be introduced without extra weight or external resistance. This applies particularly to flying at heights.

Weight

The total weight that is carried on an airplane is obviously all-important, and it will, therefore, be useful to see what prospects we have of decreasing weight of airplanes of any given type. We will divide the airplane into the following components:

Useful load
Motor unit
Fuel, oil and tanks
Remainder, being airplane parts proper

The object of the airplane flying at all is, of course, to carry a useful load for a certain distance. In this load we do not include fuel and oil, and as the tanks vary in weight with the amount that has to be carried, it is convenient to include in the fuel and oil the weight of the necessary tanks and pipes.

For the purpose of general analysis it is assumed that the motors consume the same amount of petrol per b.hp. per hour, and the figure, 0.7 lb. per hp. hour, is sufficiently accurate to cover the weight of fuel, oil, tanks, and pipes. There are, of course, engines which do better than this, and many which do considerably worse. It is, however, a fairly good average for motors as they are now.

Analyzing a number of airplanes that have been used under active service conditions it has been found that, apart from the useful load, the motor unit, and the petrol, oil and tanks—the remainder representing the airplane proper—is very nearly one-third of the whole weight—32 per cent being rather nearer. This weight includes the wing structure complete, the body complete with its fairing, floor, seats, controls, instruments, etc., the tail plane, elevator, rudder and fin, and the landing gear and tail skid. This weight is on the average made up as follows:

	Percentage of airplane parts Per cent	Of total weight Per cent.
Wing structure complete	41	13
Body complete	41	13
Tail plane, elevator, rudder and fin	6	2
Landing gear	12	4

If we take 32 per cent as the weight of the airplane proper we have the balance of 68 per cent to divide up among the motor unit and its fuel and the useful load. Various diagrams were then shown depicting the combined weight per hp. of the motor unit with its fuel, oil and tanks for various times of flight.

We have now only to decide what percentage of useful load we shall carry, and for what time it is to be carried, and we can find at once the weight per hp. of the complete machine.

Possibilities of Reduction of Weight

The weights of the airplane parts have now been fined down to a considerable extent, and, except for the use of newer materials, progress in saving weight is not likely to be very pronounced. Undoubtedly as time goes on we shall learn to make equally strong structures for less weight, and the development of aluminum alloys and pressed metal construction may help to a marked extent. At the present moment wood is used very largely in the construction of both the bodies and wings. To a great extent this is due to war urgency, and no doubt airplanes of the future will be made of more durable materials.

The chief particular in which it is probable that weight will be reduced is in the weight per hp. of the motor. Although progress in this respect has been remarkable, it is probable that we have not nearly reached the limit of weight in internal combustion motors. At the present day the complete motor unit—i.e., the motor itself, the airscrew, water and radiator if water-cooled, exhaust pipes, and so on—weighs generally from 3 to 4 lb. per hp. Certain very light motors have been made in which the weight is very little more than 2 lb. per hp. It is quite conceivable that in the next few years motor units of 1½ lb. per hp. will be available, and in all possibility with the improvement in material will enable us to make motor units weighing not more than 1 lb. per hp. in the more distant future.

With regard to fuel consumption the best petrol motors have a brake thermal of efficiency of about 30 per cent. It may be this will be improved, and here again saving of weight may be effected.

The only motive power used to-day is supplied by internal combustion engines. Some day no doubt a lighter form of motive power will be developed, and it is in this respect that the most startling progress may be expected.

Resistance of the Airplane to Forward Movement

The resistance of the airplane is made up of two factors. The first is the resistance of the main planes. The second item is made up of the resistance of the body, the struts, wires and fittings of the wings, the landing gear, tail plane, rudder, and so forth. These can all be grouped together under the general term of body resistance. It is in respect to the reduction of this resistance more than anything else that the modern day airplane owes its superiority over that of the original Wright machine.

The first man who seems to have understood the importance of reduction of resistance was the late Edouard Nieuport, who in 1909 produced an airplane with a very fat body which almost completely enclosed the pilot and succeeded in making a big improvement in speed on an airplane of comparatively small power. Since that day all modern airplanes have bodies which are enclosed as completely as the requirements of the pilot's view allows.

Details of Resistance

The resistance of the external parts of the airplane has now been fined down to a considerable extent; modern day airplanes do not differ very much in this respect. The various components of the airplane will generally be found to have the following proportional resistances:

	Per cent.
Body	62
Landing gear	16
Tail plane, fin, rudder and elevator	7
Wires, struts, and fittings of the wing structure	15

It will be noted that by far the larger part of the resistance is made up of the body itself. A large part of the body resistance, however, is really used in providing cooling for the engine, whether it is an air cooled or water-cooled engine. Whether the radiator is let into the body or is external to it does not appear to make a great deal of difference. The body is also of greater resistance than it need be, as it is necessary that the pilot shall have a good view and shall not be entirely enclosed. Bodies round in section are somewhat lower in resistance than the square bodies, but the difficulties of manufacture generally make their use undesirable. It is not likely that we shall be able to reduce the body resistance to a very great extent unless we can use a motor which does not require external cooling. It is true that it would be possible to use the complete surface of the body or of the wings as a radiator and by this means the waste of power would be negligible, but in order to do this the radiator becomes an impracticable and heavy piece of apparatus.

The resistance of the landing gear is considerable and it is difficult to see how this can be very much reduced. It has been suggested by many people that the landing gear could be stowed away inside the body while the airplane is in flight, and no doubt in the future this may be done. It is, however, very difficult to design a folding landing gear without an undue sacrifice of weight or a large increase in the cross section of the body.

Another factor which influences the resistance of the airplane to a considerable extent is the increased resistance of the parts of the airplane that are in the slip stream of the airscrew. The allowance to be made for this is not known

very definitely, as in either a tractor or pusher airplane the resistance of the body itself tends to increase the efficiency of the airscrew.

Thrust Available for Flight

The thrust available from the airscrew varies directly as the horsepower of the motor, directly as the airscrew efficiency, and inversely as the forward speed of the airplane. If the efficiency is constant the thrust available at any speed will depend upon the horsepower of the motor, consequently the weight per hp. of the whole airplane is an expression for the ratio of thrust to weight of airplane. I have referred to a general method for obtaining the proportional weight per hp. of an airplane knowing the weight per hp. of the motor, the number of hours of flight, and the percentage of useful load that has to be carried. As in practice the efficiency of the airscrew does not vary much, and as the resistance of modern day airplanes per lb. of weight is fairly similar, it is possible to predict rather roughly the performance of the airplane simply from the weight per hp. figure.

Airscrew Efficiency

We have said that airscrew efficiency does not vary much in practice. There is, however, a considerable difference between the best attainable efficiency and that obtained under certain conditions.

As Lanchester has shown in Aerodonetics, for maximum airscrew efficiency the pitch must be a little greater than the diameter. From first principles also it is easy to see that the diameter must be a certain minimum so that the loss in the slip stream shall be small. Now it is always convenient to have as small airscrews as possible, for when it is smaller it will be lighter and less in the way.

Again, unlike the screw of a ship, the airscrew has to work at largely different thrusts when the airplane is going slow and climbing than when it is going at full speed on the level. As a consequence the airscrew of a modern airplane nearly always has its maximum efficiency when its effective pitch is at its largest—i.e., when it is going fast, and its efficiency is lowest when the pitch is small, that is, when the airplane is climbing.

Another disadvantage when the airplane is climbing is that the engine is more heavily loaded, and in consequence the airscrew revolutions are lower. With engines as they are, this always means less horsepower. We need, therefore, either a change speed gear or an airscrew in which the angle of the blades can be changed. This will avoid a drop in horsepower, and to a lesser extent the loss of efficiency when climbing. We also need, however, a propeller of varying diameter so that combined with a change of angle and a suitable engine speed we should get nearly a maximum efficiency under all conditions.

There is not much room for improvement in airscrew efficiency working under the best conditions, as the efficiency is as high as 85 per cent. When climbing, however, the efficiency will frequently drop to less than 65 per cent.

Attempts at variable pitch or variable angle airscrews have been made, but none seem to have reached a practicable stage. The design of such a screw is quite possible, and no particular invention is required to make it a success. As the demand undoubtedly exists variable pitch airscrews will be made successfully, and will become a standard part of the airplane equipment in the near future in all probability.

Performances of the Future

The airplane flown by the Wright Bros. had a speed of 30 to 35 miles per hour, and we have in a few years made airplanes that fly four times as fast. What then are the prospects of the future?

Before considering this we must consider the effect of height on the speed at which an airplane flies.

Very briefly the resistance of the airplane and the horsepower of the engine each fall off when the density of the air decreases, but with engines as now designed the horsepower falls off faster than the resistance.

It is now proposed to consider what speed we are likely to attain in an airplane of the future flying at a height of 10,000 feet. As it is a hypothetical airplane we are entitled to assume that all the improvements outlined in the preceding paragraph are incorporated into it. The assumptions we will make are:

(a) That the planes have variable camber.

(b) That the motor unit weighs 2 lbs. per hp., and will maintain this horsepower at all heights up to 10,000 feet.

(c) That the body is the best possible shape, completely enclosed with no external fittings.

(d) That the landing gear shall be folded inside the body during flight.

(e) That the airscrew efficiency shall be 85 per cent.

(f) That the percentage of useful load carried shall be 15 per cent.

(g) That the duration of the flight shall be two hours.

Assuming that the weight of the structure is as at present, the weight per hp. of the complete airplane will be 6.4 lbs. As we are considering a faster airplane than is at present made it may be as well to allow a little more weight for the airplane structure, and we will assume that the weight per hp. is 7 lbs.

We will now turn the percentage weights into pounds by assuming that the useful load is to be 450 lbs., which may be two people and luggage or perhaps one man and mails. The gross weight of the airplane will therefore be 3,000 lbs. and the hp. of the motor 430. We will imagine that the airplane is of a type in which there is practically no resistance due to the slip stream of the airscrew, also that the motor requires no external cooling. In order to accommodate the engine and crew we will consider that the biggest cross section of the body is 12 square feet approximately round in section. The resistance of such a body will be about 2 lbs. to the square foot at 100 feet a second forward—i.e., 24 lbs. in all.

The resistance of the rest of the airplane by careful design can be kept down to 16 lbs. at 100 ft. a second, consequently at that speed the total resistance other than the wings will be 40 lbs.

The area of the wings necessary will be governed by the speed at which it is considered reasonable to land, taking 60 miles per hour as a possible speed and assuming that the planes can be converted into a deeply cambered section for landing, the permissible loading of the airplane will be 15 lbs. per square foot, making a total surface of 200 square feet.

We will now take a speed of 350 feet a second, or 240 miles per hour and find the horsepower required at a height of 10,000 feet—i.e., where the density of the air is .74 of the normal. The wing drag may be taken as a fifteenth of the weight as with wings of varying camber we shall be able to get a high lift drag ratio even at a small lift coefficient. The resistance due to wing drag, therefore, will be 3000 ÷ 15, which is 200 lbs.

As the airplane is flying at 350 feet a second the body drag will be 3.52 times what it was at 100 feet a second, which will be 490 lbs. As, however, the air is 26 per cent less dense its resistance will be reduced to 364 lbs.

The total drag will be the sum of the body drag and the wing drag 564 lbs. in all. Taking an airscrew efficiency of 85 per cent on the power required for flying it will be very nearly 430, which is just the power available.

The example just taken may seem fantastic to many people here to-night; it must be remembered, however, that when the Wright Bros. were flying at 40 m.p.h., speeds of 150 may have seemed to them equally fantastic. On the assumptions we have made it is reasonably certain that a speed of four miles per minute can be obtained, and as motors of less weight per hp. become available there is no reason why this speed should not be exceeded.

The rate of progress in increase in speed will depend upon the demand for speed. If war were to last it is almost certain that speeds of much more than 200 m.p.h. would be common in quite a few years from now.

Stability and Control

In the original Wright airplanes no attempt was made to obtain stability. The airplane was definitely unstable and required considerable care on the part of the pilot to keep it in equilibrium.

The early French airplanes were a little better in this respect, but the first airplane to prove that it really was stable—i.e., it could fly without controls—was that designed by Lieut. Dunne. This was an airplane of somewhat curious construction and never became a success although it certainly was stable; on a windy day it was somewhat difficult to persuade it to fly on a straight course and its control when landing seems to have been insufficient. Lieut. Dunne, however, certainly showed that a completely stable airplane was a possibility.

About the time at which Dunne was making his experiments

certain German designers claimed that they had produced a stable airplane No record seems to exist of any test that proved their airplanes were stable, and in any case they certainly suffered from lack of control. The first airplane of normal type that was proved to be stable was produced as the result of experiments carried out by the late Edward Busk An airplane known as the R. E 1 was used for the first experiments and it was modified until it was made completely stable Tests were carried out in order to prove that this airplane really was stable, and with Busk as pilot, carrying Colonel Sykes as observer, a flight was made from Farnborough to Salisbury Plain, in which the only control used was the rudder, and this, for part of the time at least, was worked by Colonel Sykes.

Since that day most English airplanes have been designed to be stable, it has been found that for purposes of fighting an airplane that is extremely controllable is necessary, and it has been also found that if an airplane is made too stable the controls are apt to become too heavy to make the airplane sufficiently sensitive. In modern day airplanes intended for war purposes the aim of most designers is to make the machine just comfortably stable over the range of speeds used in ordinary flight, but to provide sufficiently large controls that the inherent stability of the airplane can be entirely overcome

It is often asked if we have stable airplanes why do we still have flying accidents? It would be quite possible to design an airplane in such a way that whatever the pilot did with the controls he would be unable to upset the equilibrium of the airplane. Such an airplane, however, would be valueless for fighting, and as practically all airplanes nowadays are made for war purposes there must continue to be an element of danger for the unskilled pilot

Structural Strength and Size

Increase in speed and the increase in controllability both tend to increase the stress that will be put on the structure of an airplane in flight. Experiments have been carried out to determine the increased loads that are likely to occur when doing sharply banked turns and loops It has been found that the load is frequently increased to three or four times the normal

Present day airplanes have to be very much stronger than before Modern day machines that are expected to manoeuvre rapidly are not considered tolerably safe unless the wings can support at least six times the weight of the airplane Fortunately large airplanes for peaceful purposes will not be required to manoeuvre very rapidly This fact will have an important bearing on the possibilities of aeronautics.

In an earlier paragraph it was stated that the proportional weight of the airplane parts proper was more or less constant. This applied only to machines of the sizes that are used now —i e, up to about six tons loaded weight. As airplanes are made bigger, if they are designed on similar lines, the weight of the wing structure per square foot will increase, assuming they are to be designed for the same factor of safety It is true that on the large airplanes now made this increase of weight is not very apparent because greater trouble is taken to economize in the design of the wings. This increase of weight, however, is likely to be important for machines of much larger size, but as we shall be able to use somewhat lower factors of safety the weight of the wing structure will not increase as rapidly as it would otherwise have done. There certainly is a limit of size to which it is possible to build an airplane, what this size will be the future will show It is safe, however, to say there will be no serious difficulties in building airplanes two or three times as big as the largest we have considered

Conclusion

The first few years in the history of flying have been years of remarkable progress and we are perhaps likely to be self satisfied We have no logical right to think that our flying machines of today are more than the crudest caricatures of the airplanes of the future. We engineers are a little apt to become so engrossed in our immediate difficulties of design that we do not see further ahead than is suggested by our own ideas, and make predictions for the future that only follow along the lines of progress that we can clearly see

The writer has often been asked if he thinks that flying will ever become an ordinary means of travel His answer is that he does not think, but that he knows it will become so Ten years ago to attempt to fly from place to place was considered suicide five years ago it was an adventure, today to many of us it is a very ordinary affair When we get an opportunity to use the airplane in preference to the motor car, the train, and the ship, we travel at a miserable 100 miles per hour or so in a noisy, cold and drafty construction made mostly of canvas, wood and glue, yet we reach our journey's end far quicker and in a happier state of mind than by any other means. A few years more and we shall laugh to think of the airplanes of which we are now so proud, we shall shudder at the risks we ran, and we shall travel with comfort speed and safety

Seaplane Float Construction

Third Installment

By Charles G. MacGregor

Curtiss Aeroplane and Motor Corp.

Step Construction—After the topside planking is complete the float is loosened from the mold, lifted off, turned completely over, and is set up on a padded mold for the completion of the step and bottom planking The step floor is built very stout, and is rabbeted to take the stern bottom planking, and the inner skin of the bow bottom planking,

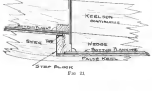


Fig 21

the outer skin running to the after edge, or it may also be rabbeted in with the inner skin A bulkhead is arranged if possible, so that it will come at the step, in order to stiffen the float at this particular part. The keel, keelson, chine stringers and all longitudinal members are made strongest about the step. The lower edge of the keelson follows the line of the bottom planking to the face of the step floor, and thru jogs up over the step to the line of the stern bottom planking The keel ends are notched into the step floor (Fig 22) The chine stringers are carried continuously past the step, and a wedge is riveted to the lower edge to make up the depth necessary for the step This wedge is rabbeted so that the side planking carries down over the joint. The ends of the chine wedge and the step block are half dovetailed and riveted Fig 21 shows the stern planking carried over the step block with the outer skin rabbeted A cross member is screwed over the ends of the stern planking forming a clamp The keelson is continuous with a wedge added ahead of step The lower edge of the cross bulkhead is rabbeted into the floor or step block Fig 22 shows the method previously described. Fig 23 shows the keel continuous where no keelson is used, it is passed through a hole cut in the step block and riveted when in place

False Keel—To protect the bottom planking from wear and tear, a false keel is fastened on outside the planking, usually extending from about two feet from the stem to the

after end of the skeg in the step float, and right back to the sternpost in the stepless float (Figs 5-6) This is fastened on from the outside so as to be easily removable for replacement. Sometimes a brass strip is screwed to the underside of this for additional protection, as previously mentioned under "Keels."

The materials used in their construction are ash, oak, elm, mahogany and yellow pine

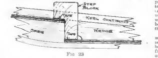


Fig 22

Spray Strips—These strips are fitted along the chines on the underside, so as to deflect downwards the sheet of water or spray that is thrown out from the bottom when the seaplane is taxi-ing, so that the spray will not catch on the propeller or propellers. They extend from two feet from the stem to the step

The materials used for these are similar to those used for the false keels.

Skeg—This is fitted at the back of the step in line with the

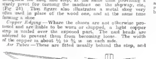


Fig 23

keel. It is made of pine, ash, oak or mahogany The lower edge is protected by the false keel Sometimes a brass casting is attached at this point called a shoe, to protect and strengthen the skeg and step, at the same time providing a sturdy pivot for turning the machine on the shipway, etc., (Fig 24) This figure also illustrates a metal skeg very often used in place of the wood one, and at the same time forming a shoe

Copper Edging—Where the chines are not otherwise protected and are liable to be worn or chipped, a light copper strip is nailed over the exposed part. The nail heads are soldered to prevent them from becoming loose The width of the copper is about ½ to ¾ in on each side.

Air Tubes—These are fitted usually behind the step, and

Fig 24

extend from the deck down to the bottom planking Their purpose is to admit air down to the back of the step to break the suction of the water on the bottom when the seaplane is running at planing speed, and so enable the machine to get off the water They are built of sheet steel or copper. The ends are flanged over rings screwed to the deck and bottom planking, and soldered. The planking is reinforced with blocks around these holes. Packing is placed between the planking and the rings before they are fastened down to ensure watertightness. The Tee Tube is another type which is used where the separate tubes cannot conveniently fit in. (Fig 25).

Drain Plugs—Each watertight compartment has a drain-plug at it's lowest point, through which all the water can be drained. Two types are commonly used as shown in Fig 26. One is unscrewed from the outside by means of a screwdriver The plug is secured by a wire attached to it, projecting up through with a loop on the upper end inside, slightly larger than the drainhole to prevent it from dropping out The other is somewhat similar with the exception that the plug is in the form of a thumbscrew, detachable from the inside and secured with a small keep chain. To permit the operation of these plugs the hand-holes must be removed

Another method of extracting the water from the interior of the float is by means of copper piping, lead from the lowest point of each compartment to a deck-plate where the ends of all the pipes project through about 1½ in The lower end of each pipe is covered with a brass wire gauze strainer A small portable pump is used with a short length of rubber hose which is slipped over the pipe ends at the deck, or extensions of these pipes are carried up to a position convenient to the pilot's seat where each compartment can be pumped individually with the use of a multi tube valve

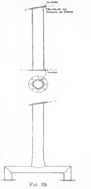


Fig 25

Towing-Cleat—There are several methods of towing a seaplane, such as from the bow towing ring (Fig 27), from the deck cleat (Fig 28) or from the struts. The towing hawser in the first method is belayed or tied to a U bolt or ring bolted to the stem (Fig 29) The second method is that most commonly used as the fittings are particularly adaptable to towing and mooring The towing hawser is rove through a closed chock bolted to the stem and is then belayed to the cleat on the bow deck, which is bolted through

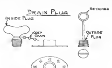


Fig 26

the deck to the interior bracing The inside bracing is connected by metal straps or steel wires to the chine stringers or side keelsons so as to distribute the pull over the bottom. From the deck downward and forward, a strut is fixed to take the forward compression (Fig 5) In the third case the towing hawser is shackled to an eyebolt through the strut at the deck connection, or to a special shackle on the pin joint of the strut. The machine is steadied by leading the hawser through the closed bow chock (Fig 30) All these fittings are made specially strong and are securely braced to the interior of the float

Handholes—Access to the interior of the float at each watertight compartment is obtained through handholes fitted to the deck These are intended for access to the interior of the float, so that it may be ventilated, examined, have any interior fittings replaced or repaired, and so that the interior drainplugs can be operated Several types of handholes used

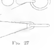


Fig 27

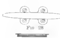


Fig 28

Fig 29

Fig 30

Fig 31

Fig 33

are illustrated in Fig 31 The first is the flat rim screw-down flush handhole The second is the curved rim handhole of a similar type. The third is the dished covered handhole. In the two former the cover screws down into the ring with a gasket between them for watertightness. A key is used to screw and unscrew the cover by inserting the stubs into the holes in the cover In the third handhole the cover is in the form of a dished plate with a hole in the center through which a bolt projects, attached at its lower end to a tripod span with the ends inserted under the ring and made so as to be easily removable A thumbscrew jambs the cover over the grommet which is inserted between it and the ring The ring is secured to the deck either by ordinary wood screws or by machine screws. The material of the covers is sheet brass for the dished plate and cast brass for the other rings and covers.

Painting and Varnishing—The use of white lead and red lead paints is eliminated as much as possible in float construction, on account of the weight added. Before the bottom planking is put on finally, the inside of the float and the inside of the planking are given three coats of varnish The outside is given at least three coats of paint or colored varnish, each coat being well sanded before the next one is applied, so as to obtain a smooth surface, and thus cut down in the skin friction. The handholes are left open until the inside is thoroughly dry

Fig 32

These floats are very delicate and light in their construction, therefore, the greatest care is taken in moving them around They are carefully padded if set on a cradle or on blocks, and if stored inside or left outside exposed to the rays of the sun, they are covered over with a damp sheet to prevent the wood from drying out too much and checking Very often the fabric cover is torn or punctured accidentally, causing considerable delay in repairing the outside covering. They are and have got to be handled as carefully as wing panels.

A step shoe is shown in Fig 32 and a boot clip frame in Fig 33

Book Review

Military and Naval Recognition Book, by Lieut. J W Bunkley, U. S. N. (D Van Nostrand Co., 25 Park Place, New York, $1 00, 224 pp)

This handbook contains official information on the organization, insignia of ranks and customs not only of the United States Army and Navy, but those of all the important nations of the world It is attractively bound in olive-drab cloth, printed on heavy coated paper and profusely illustrated with fifty plates, both in colors and black-and-white

The author first takes up the United States Army, and gives fully, but without unnecessary detail, its organization All the departments of the Army are described, with their functions. The various ranks held in the Army are enumerated so concisely as to be easily understood Etiquette and customs, both official and social, are treated in two chapters. The United States Navy is covered in the same simple, concise manner, and the Marine Corps, the Coast Guard, Lighthouse Service and Coast and Geodetic Survey are touched upon in separate chapters

The author gives ample space to the organization of the army and navy of the more important foreign countries, and the army and navy uniforms of the United States, Great Britain, France Germany, Italy, Austria Hungary, Japan, Russia Belgium Turkey and the Balkan States are fully described, with many illustrations

The various war medals of the United States are described, as are the ribbons used for the medals and badges The last of the twenty-four chapters debates guns of different classes and their parts

The illustrations in Lieut Bunkley's volume deserve special mention They are grouped in a logical manner, and by the large number of color plates combination of insignia is made a simple matter

This handbook was prepared not only for men in the services but for everyone interested in the uniforms, insignia and customs of our fighting forces and as such should prove an exceedingly useful and popular reference book

Aeronautical Patents

ISSUED NOVEMBER 27 1917

1,247,685—To Joshua Laskill Jackson Buffalo N Y Flying machine

1,247,727—To George C Schulz [illegible] Switzerland, assignor to [illegible] Flying machine

1,247,892—To [illegible] Ernest Erickson Toronto Ontario, Canada, assignor to Canadian Aeroplanes, Ltd Toronto, Ontario Canada, a corporation of Canada [illegible]

1,247,900—To Martin Jolius Cranston R I Hand power propelled hydroaero sporting dirigible balloon

Aerial Transport and Travel*

By Lieut.-Col. Mervyn O'Gorman, C.B., D.Sc.

There is talk today of aircraft for transport and travel. The carriage of goods, mails, and people, the exploration of remote districts, the conduct of photographic surveys, the searching out of valuable trees in pathless forests, the speedy conveyance of officials to their administrations in distant climes—these things and others are everywhere hopefully dwelt on by the imaginative among those engaged in air work. It would be grossly unjust to say that such hopes and fancies detract from the energies which these persons expend on their war duties, they rather indicate the intention of winning and of carrying on thereafter the life of a virile community

In a paper before the Aeronautical Society, in June this year, (see Nov 1, 1917 issue of AVIATION AND AERONAUTICAL ENGINEERING) I gave reasons to show that in the interest of the war we must care about the future of transport by aircraft. I will recapitulate the position under *A*, *B*, and *C*, for there are three stages in the logic of the matter —

The Three Stages

A We are to have an Air Ministry and an Air Force the Act shows that they are not temporary—a token from which alone we may say that we intend to have a fighting Air Fleet

B An air fleet differs from a sea fleet in being much more easily expendible. No one would dream of rebuilding the British High Seas Fleet six or eight times per year of war, but an air fleet in action requires, and will continue to require, at least this. Thus the airplane has in this context the interesting singularity of being intermediate between a cartridge and a battleship It is not quite so rapidly expendible as the former, but it is an expendible munition, and when we decide to have an air fleet we also decide, in logic, on the third enclosure, *C*

C This corollary is that we will maintain an aircraft construction organization in peace that shall be competent to produce some six or eight air fleets per annum in war

At present we have such an industry—not large enough, perhaps, but we have at least a live and flourishing plant which is bearing fruit, which can grow, and which, be it noted, can also expire A living organism can be killed by deprival of oxygen. In three minutes a man is drowned, and 40 years' training of brain and hand can be thus quickly reduced to an inert mass. Similarly rapid is the rate of disintegration of a highly organized technical production department like the Aircraft Industry if it be starved. Today war orders continue at full flood to fill up the wastage. If they stop suddenly we shall find within three months that the shop organizations are broken up, that all that remains to us is the husk, we shall realize that we could, by timely measures, have saved much of our expensively purchased experience and organization, and have retained a value far greater than the mere buildings and plant Once the designers and workmen are scattered, that which is so difficult and expensive to build up will be gone. Our capacity for the production of aircraft will be an object of derision like a bouquet of hairs in an old broom

This simile will have succeeded if it has led a few score of persons to inquire, "What on earth are we to do to keep this mechanism of production in being without keeping up in peace the war rate of expenditure?" A part of the answer was outlined in my first sentences, we must so utilize aircraft on commercial duty, and so nurse it in its days of trouble, that it shall itself earn the best part of its keep.

If aircraft using can be induced to pay, aircraft making will of itself continue. But, in spite of the firmest belief in the value of aerial travel, the mere institution of services takes time Neither three months, nor six months, nor a year, will see a thriving mercantile air fleet engaged on its routine duties and issuing its routine orders on which the construction business depends. Yet a less period of inaction than this will extinguish the industry. This is the period I ventured to call the "hiatus" in the discussion on Mr Holt Thomas's historic lecture last May To bridge the hiatus we must do something now. There is no other alternative. No one expects a continued unrequited expenditure of from 25 to 50 million pounds per annum on aerial war material in peace time On the other hand, no one would object to our making even this large amount of aircraft if it nearly earned its keep by remunerative services in any of the travel and transport businesses, or even if we could be assured that, after a period of Government support, it would eventually draw near to the standing of a self supporting industry

Historic Precedents

If we look back to the birth of the railway and the steamboat we see that for some years they struggled against public apathy—though their potentiality for good and for the creation of wealth and trade was almost as great in Watt's time as now This apathy, amounting to boycott, rendered them unremunerative for a long period, and deprived the world of travel, and joy and change, and fresh air, and trade progress for well nigh a generation In the case of the road vehicle, which we now call a motor-car, we had something worse than apathy—we had legislation for the alleged protection of the public, all meant in kindness—which killed the motor-car of 1837 and retarded the car of 1892, till France was well ahead of us. In the case of dynamo electricity we underwent a process of protective legislation against shock and fire possibilities, which threw us well behind Germany and the United States. The story of legal impediments to scientific advance makes one wonder whether we are a free people—that is, with freedom to advance, or are we only set on freedom to stagnate?

The greatest danger that aircraft has to fear, after public apathy, is legislative interference It is not that the British law, excepting only when it is panicky, is worse made or more malignantly administered than another The kindly intentions of legislation towards the public are generally as laudable as our laws in technical matters are detrimental. Yet such a community as ours can only live and thrive on its technicians. We are prone to drown the puppy lest he should bite, instead of adopting our own unique maxim of allowing the law to lag, so that the puppy shall have one fair bite before he is muzzled.

Anti-Progressive Legislation

We now know that it was shameful to have waited for the war before building up our Department of Scientific and Industrial Research No branch of administrative expenditure was known to pre-war politics whose function was to venture forth, or to encourage us by Press publicity, or otherwise to advise the public to risk a little inconvenience during the period of evolution of a difficult art or science The four mile, the twelve-mile, and even the twenty-mile per hour motor-car speed limit prove that technical legislation has hampered and did not encourage. Of legislation relating to aerial transport it may safely be said that it is a case requiring the greatest delicacy of handling. It must be taken as certain that Government assistance, I do *not* say subsidies, for the industry must be forthcoming unless it is doomed, but even if this assistance were certain there remains cause for anxious thought today.

The danger of Government support lies in the conditions which a self-protective public is liable to impose before the technical possibilities are sufficiently known to form the basis for any sort of legislative interference. These conditions are liable to be all the more onerous since they could be imposed as of right, and regarded as a *quid pro quo* for the "assistance" The fearful might say that great unknown risk to those on the ground (*omne ignotum pro magnifico*) is involved in any program of commercial aeronautics. The braggart has already talked of a sky darkened by airplanes, of the cerulean clotted with colliding aircraft, and the timid voter silently wonders how *he* is to be protected from the debris. Luckily we have the facts with which to dispel this apprehension. Today we may safely say that £50,000,000 worth of aircraft is yearly poured out from this country's factories. The large majority of this is flown to its destination, or used for tuition and defense at home, yet we still see the sun.

We have a full measure of the nuisance exaggerated by the more hurried training of fliers, and the extreme lightening of structure imposed by war conditions. Such nuisance as there is is purely local, and is really negligible Now there is no prospect for many a long day of any such £50,000,000 output on commercial aerial transport. It is merely necessary to recall that our total expenditure on merchant shipping is a mere fraction of this to see the absurdity of apprehending and legislating as if we were to have this immense user of aircraft.

* A lecture delivered before the Royal Society of Arts.

There is no slightest probability of any nuisance in excess of what little we suffer today, even if we had, which I see we shall not have, an aerial fleet of this magnitude

I have indicated the need for restraint in law-making, but there is also need for positive official action, if the bells that ring in peace are not to sound the knell of aerial activity The Allies must, during the war, frame a joint policy as to the tolerance of each other's trade and postal aircraft, and agree to air routes throughout the parts of the world which they control With the large expanse of our colonies and our own industrial and postal importance, we have much to offer to the Allies which will be a valued equivalent for that which we shall obtain from them in the way of alighting rights. Being an island, and accepting, as we must accept, the proposition that the most significant section of aerial transport will be outside the confines of Britain, we need that our Allied neighbors shall extend, not only tolerance, but welcome to our machines when engaged on their transport work We and our colonies should have to be prepared, and, I believe, are prepared, to extend a corresponding welcome to their airmen at home

Preparing for Peace

International agreements, even though simple in subject-matter and non-controversial, are always long drawn out Everyone who understands factory organization will agree that we cannot afford to wait until after the war for these parleyings to begin Our aeronautical organism will assuredly become disintegrated too quickly If we can get four or five willing men round a table to agree to admit aircraft mutually, to register them, to agree to simple preliminary rules of the road, and to agree that their respective countries should initiate a few lines of landing-grounds so as to constitute safe routes, the early days of trade flying have little more to ask for from the foreign offices of the world

No doubt in some four or five years of active aerial transport organization work the paltry fifty or hundred airplanes of our early post-war efforts at transport and travel will have grown up into a significant carrying trade for high speed work, large quantities of aircraft will have been used for commercial purposes, and it will be found useful to introduce and there will be experience enabling us effectively to introduce valuable regulations for the protection of passengers in aircraft, and the public on the ground beneath At the present day it is clear to all who have eyes to see that no adequate knowledge exists on which to frame rules with discrimination and without grievously hampering technical development

The Danger of Safety

I can imagine a legislature winning a round of applause from the *inane vulgus* by driving a hard bargain with the wretched trader, who, in the face of starvation, might accept any regulations, however hampering, in exchange for the means to live I can imagine the imposition of tests of airworthiness, strength tests, the enforcement of hobbies such as multiple engines, silencers, special alighting gears, the carrying of parachutes, fire extinguishers, wireless equipment for calling for aid, and countless other things, which may, no doubt, come in their own time, but which would clog the versatility of the engineer, and for years condemn to unproductiveness the nascent industry of air travel The payment of an army of inspectors would be put down as encouragement money, and would be a charge against the aeronautical vote A landowner would ask for the power to capture the flier who has most reluctantly alighted on his ground He might ask for a law allowing him to impound the airplane, on the chance of his registered number being inauthentic, and so secure payment of the damages which he wishes to claim

It is just possible that regulations of this sort might meet with support, as much as support is at present accorded to the 20 mile speed limit of the motor-car They would be next to impossible to remove, though they might be demonstrably hampering the aircraft development of the country to an enormous extent. The intentions would be good, the desire would be to secure that only the best aircraft were used, and that the public suffered no injury by its use It was for half a century thought that the public could suffer no injury by the four-mile speed limit being imposed on mechanical traction! Later it was thought that as a 12 mile an hour speed limit was ample for a coach-and-four, it must be an ample speed for a car, and so the automobile industry passed to France and Germany, in spite of the fact that the first car plied for hire in England early in the reign of Queen Victoria, when there was *no* speed limit

A Safe Prophecy

Let us rest assured that the amount of civil aircraft will for some years be so much less than the amount of military aircraft now existing, that the total of damage to property and inconvenience to the public, which we at present know to be small, will be much further reduced in proportion to the lesser numbers, the future technical advances, and the less strenuous conditions of manoeuvering imposed on peace airplanes

Labor

Labor—Among the expectations based on aerial transport and travel are those of employment for individuals throughout the whole social scale as well as officers and men from the Army and Navy Our producers, and therefore their employment of labor, depend on the bodies which employ aircraft—viz (a) Primarily the Air Force (b) foreign buyers, nations and colonies and (c) companies instituted for transport and travel, including postal duties. All these bodies need labor, and all are interested in continuing harmonious relations between those who direct the work and those who manually carry it out

It has been suggested that since the aircraft industry is a new industry, an exceptional opportunity exists of introducing a totally new atmosphere of harmony unembittered by the old trade quarrels This is most desirable, but the novelty of the technics of aircraft has not in fact eliminated the old trades at all on the contrary, it has developed the demand for these "Tradesmen" The Aircraft Industry is not a new trade in the sense in which that word is used by the world of labor in the phrase "Trades Union" The Aircraft Industry includes members of almost all the engineering trades, as well as important additional trades such as woodworkers, carpenters, organ builders, cabinet makers, fabric workers, etc, and it is necessary for that harmonious relationship to be established between employer and employe, in spite of the fact that the history of all the old trade differences will unavoidably be also the history of the persons and corporate bodies imported into the new industry, with this addition, that a trade quarrel on the subject of organ pipes or on the piece work price of chairs, may mean a stoppage of airplane work, owing to the newly imported craftsmen holding on to the old unions

Again it would be unintelligent to pretend that aircraft making can be developed under a compact between employes and managers which shall guarantee continuity of employment for all the manual workers in exchange for a continuity of labor supply to the other The difficulty is a fundamental one and perhaps is a worse difficulty in the Aircraft Industry than in most others. It is this The technical developments of the art, the unforeseeable shortage of material, and the unavoidable changes of method and of materials, tend, let us say, at one time to the employment in an aircraft factory of 50 per cent of wood workers and 30 per cent of steel workers, and there is no human authority who can with sanity pretend to say that in some brief time these proportions will, or will not be widely changed If steel or aluminum were to form a greater part of the structure than they do now, because of safety, or diminished fire risk, or what not, any agreement with the wood workers' union for continuity of their employment would install them as a paid but non-working body of pensioners on the industry Alternatively, British aircraft, hampered by such an agreement, would remain locked in its old technical groove and be debarred from adopting the devices and inventions which throughout the rest of the world would be improving the machine Surely a hopeless prospect for a technical service required for war!

It is clear, then, that the agreements between manual and brain workers on aircraft must be part of the general agreement on which our new millennium is to be based

To Save Disappointment

Employment of Soldiers and Sailors—The industry will, even when the most strenuous efforts have been made to save it by such continuance of air service orders as are at all possible and when such aerial transport work is started as may be decided on, still be cut down drastically Hence very great disappointment will be spared to many a good man by realizing thus early that there will be no expansion of employment on aircraft which will absorb them wholesale, but rather a manifold shrinkage

Public Contact

Accidents—It is unfortunate that the chief contact which the public of England makes with aeronautics is in relation to accidents and casualties. The achievements appear, it is true, but it is almost impossible to visualize them save perhaps in the case of an occasional flight of unusual distance, such as the recent 3,000 mile flight from London to Constantinople, or between London and Turin, and these things appear to be disconnected items giving no impression of the hundreds and thousands of miles of continual flying which is taking place. These show flights are few, not because they cannot be frequently achieved, but because war does not provide for show and *reclame* The public cannot by mere lecture be brought to the point of view which is standing with those who have been fully familiar with aircraft, we are so imbued with its utility and versatility, that we are no more discountenanced by occasional breakages than we are deflected from hiring a taxi by seeing a sideslip against the curb Those actually engaged in design, who naturally need to use every element of experience which accidents may bring to enable them to perfect their work, are anxious to study and analyze these occurrences

Reasons for Accidents

Air accidents can be divided into groups for the purpose of their study, and when we proceed so to divide them we find that by far the largest category includes those which are due to the two following circumstances (1) The absence of landing grounds distributed in easy stages to which a flier can turn for refuge if his engine should stop, (2) the inexperience of fliers themselves, since the majority of the experienced have been drawn off to the war If we remove from the records of accidents, other than tuitional, all those which could have been avoided were these causes non-existent, the residue would be less significant in *fact* and vastly less significant than is the *impression* abroad Beyond this it is still reasonable and advantageous to sub-divide the causes of this residue of accidents into classes, so that attention should be drawn to that which may be eliminated, be it in design or in handling

Of the remainder, the most important is what is commonly called "Pilot's error" This does not imply that he is blameworthy In war, manoeuvres which are definitely hazardous are necessary, people may be surprised to hear that to loop the loop is a useful war manoeuvre which may greatly puzzle an antagonist in the air, since the looped path takes the place of the expected forward movement, and therefore falsifies the aim of the adversary, or throws out all his estimate of the direction in which to fly for purpose of intercepting him Another manoeuver, known as "spiralling," or "spinning," if contrived to give the impression that the airplane has in fact been thrown out of control, is one of many ruses for breaking off a fight The learning of these manoeuvres must be achieved before they can be used in war, and tends to swell the number of broken machines Rapid diving, such as might be made in an attack on observation balloons, may similarly be a cause of accident until judgment is acquired in the method of "flattening" out the dive. Even to describe a *very* small circle in a horizontal plane implies unusual stress on an airplane, if accomplished at high speed None of these manoeuvers are called for in trader work, while, to add to the comparative safety of the peace aircraft, we can appreciate the effect of removing the war demand for high performance and speed. Under fire and pursuit safety comes from lightness and manoeuvrability, as much as, or more than, it does from strength and solidity, in trader work the conditions are largely changed if not reversed

Reduced Risks

Aircraft travel and transport therefore will, if landing-grounds are provided, not be exposed to any of the risks above named, and accordingly from the list of accidents which occur today we must eliminate almost all these in any prognostication as to the future safety of flying Before such an audience I need not belabor the so-called *air pocket* It never did exist, and generally there seems to be little probability of any airplane, even when designed on the factor of strength used today, with the limited science of today, being broken in the air under the conditions of aerial travel

Much need not be made of the fire dangers on aircraft, for when the matter is regarded dispassionately, the fire risk by actual experience is small Of the fires which have occurred since thousands of airplanes have been turned out per month, the large majority have arisen when the airplane has struck the ground and the petrol vapor from the broken up tanks has come into contact with a spark Now this breaking-up of a machine on the occasion of a forced landing again becomes a rare occurrence if the line of landing grounds suggested for aerial routes is provided Most of these smashes, some fraction of which have resulted in fires, have occurred by reason of the flier holding up his machine unduly long in his search for a suitable place to alight in a country where no provision for alighting exists

Increasing Safety

Of the mechanical precautions taken to avoid fire, we know that already it has been possible to make a magneto which, when filled with explosive vapor and surrounded by it, gives rise to no ignition of the mixture. We have also learnt that the back-firing or "popping" of an engine into the induction pipe, which throws a flame back, can be made innocuous by drawing the air supply of the engine from outside the body work This, indeed, is standard practice today The use of electrically heated clothes, called for by fighting at heights such as 20,000 ft, will not be nominally desirable, and as for appliances for wireless telegraphy, which will have their place for giving trader craft their direction and for calling to the ground, they will not under peace conditions impose any risk of fire which cannot be circumvented In general, the standard of safety from this point of view will be automatically enhanced in all transport work Carelessness, such as makes people bring matches into a T N T factory, cannot be expunged from the human race, but this class of occurrences need not disconcert us at all In filling up with petrol there is the chance of spillages, and no doubt but that every aerodrome should be equipped with portable fire-extinguishers of light weight made available at filling points, and no doubt also but that all large airplanes will carry one in an accessible position, until the proved absence of utility causes them to be relinquished

Fog Dangers

The accident, if it can be so called, of losing one's way in a fog will be far less likely to result in disaster, when, to quote it once more, there exists a multiplicity of landing-grounds, because, on the one hand, no fog has been found to extend more than a very limited height, say, 700 yards maximum, and, on the other hand, because we now know that fogs are quite local in their occurrence at any one moment A befogged flier, instead of alighting through a foggy patch, merely moves a little farther on before landing This does not imply that projects for signifying to a flier who is above the fog the correct position of his aerodrome by pilot balloon or rasant lights are to be discarded, but this is not the place to deal with that point

Parachutes

Parachutes are spoken of, but by many fliers are not thought particularly desirable. We know that at present they require a height of some 500 feet to open out and afford the safety which they appear to offer, and it is usually below these levels that the flier becomes convinced he is to be exposed to some risks, say, by the conditions of the ground together with the stopping of his engine which causes him to alight One would have to be very seriously out of touch with those who fly daily and really knew their job, if one continued in the impression that numbers of accidents are the inevitable concomitant of aerial travel, and it is sufficient to say that any such opinion may be dismissed as one which has arisen from the peculiar conditions of Press publicity in war and the exclusively high pressure and high performance conditions of the development of aeronautics up to today The lack of contact of the public with the serious and successful work which has been achieved has already been mentioned

Wind Tunnels

Research—It is possible that someone will question the need for research and for State endowment thereof, it may be said that we are well on and can now trust to practical developments, since root and branch retrenchment of expense is called for This is a complete *non sequitur.* If cheap progress is wanted, the cost of progress is enormously reduced by making and testing models two feet wide instead of making structures of a 100 foot span The ratio of cost is as £10,000 to £50, and it is the £50 scheme which I am advocating I cannot

give a list of researches, but ask you to consider the following examples. We need the scale corrections from model parts to full size, we need to test propulsive mechanisms, without building them, we must know the value of new wing sections, of reflexed wings, of hinging the flaps for controls, we must, in order to get any airplane stable, know the movement of the center of pressure on the wings when the attitude of flight is varied, we must study the effect of vibration on structural parts, etc

We are aware that the great utility of aerial travel is speed, that the great enemy of speed is head resistance, and we must be able by simple model tests to forecast the speed which will be attained by a given design We must be able to know, before we introduce a variation in design, the amount of economy of resistance which can be made by altering structural parts All this class of work can be effected in the wind tunnel, and already most serious aeronautical construction firms are equipping themselves with a wind tunnel Probably the greatest value of such equipment is its educational effect The wind tunnel has fought its way to the front, in spite of much opposition, and it is still to be recognized that unless its indications are interpreted by skilled persons grave blunders will be made, but this in no wise detracts from its utility when properly employed

Engines, Air Screws and Other Things

We are aware that the thermal efficiency of engines employed on aircraft is as high, in spite of their small size and weight, as the efficiency of Diesel engines giving thousands of horse-power Yet this figure is only 30 per cent, and by research alone can we hope to obtain an extension of this percentage The study of airscrew efficiency, the effect upon it of the body, the means for making airscrews smaller than they are at present, and thereby simplifying the whole outline of an airplane, is a matter which research must tackle The use of new alloys, of new methods of totally enclosing the flier in an airplane, new methods of housing the landing gear, so as to get rid of its head resistance, the protection of the fabric of the wings from disintegration by ozonization due to actinic light, all these and countless more matters can only be economically and expeditiously studied in laboratories equipped for the purpose, they will effect enormous economies in aeronautical upkeep, and aero research must be pressed on and financed after the war

Broadly, it may be said that air transport will not develop save by taking a line of footprints given by research To say that we want it, does not by any means ensure that it will proceed apace as it should Research of various kinds is remunerative in two different ways (a) quickly, and (b) eventually Those studies which conduce to (b) rarely produce (a) a quick return On the other hand, researches which afford us (a) are very likely indeed to be remunerative both quickly and eventually

If we now subdivide the various researches which might forward aeronautics into two other classes—those (a) which result in some proprietary advantage to the inventor, and those (b) which have a general effect on progress, and which are not susceptible of being privately protected—we find that there is every inducement to the research worker to concentrate upon the class of improvement which I have called (a) in each of the above pairs of groups, that is to say, the device which can both be made proprietary, and which is remunerative quickly.

This must, unless we are very foreseeing and courageous, operate to deflect research workers from the other and frequently much more important class of study, viz., those which are of *general* application, and those which are eventually of great money value to the whole of the industry, whether of construction or of transport.

Patent laws stimulate advancement by providing that there shall be a reward, and that all and sundry shall not be able to possess themselves of the fruits of one man's labor, and thereby dispossess him Means must be devised for securing that the British industry, as a whole, shall not be tempted to exclude from its study the great groups which I have classed as (b), which are so frequently not protectible by patents, and this business falls naturally to the new Department of Scientific and Industrial Research, who will, no doubt, find the hearty cooperation of the Society of British Aircraft Constructors and the Aeronautical Society It is for the public to see that the determination toward progress exists, and then the outcome will first of all be the necessary funds, and thereafter the harvest of results and economies.

The Air Board has formed a Civil Aerial Transport Committee, which is engaged in considering these and most of the other matters dealt with in any such discussion as this, and if they recommend active steps to be taken, let us hope that there will be firm public support for any expenditure and assistance which shows proper foresight, always with the considered approval of the new Air Minister

Air Roads

Routes—One of the things wanted now is some inquiry made experimentally by actual flight for the purpose of determining the best aircraft trader and postal routes which may be useful and eventually payable London-Paris has been suggested, with extension to Marseilles, Turin, and Egypt. Links between capitals have also been spoken of, and links with India and South Africa, etc. Short runs will probably come first. In all short distance runs the problem is complicated when the existing rail and steam facilities compete There is a marked advantage for aircraft every time that transhipment of any kind occurs on the ordinary means of transit This favors London-Paris and London-Dublin, for example. Similarly, and for similar reasons, whereas no great advantage might be gained by a London Glasgow route, where the train travels at fifty miles per hour, and the journey can easily be done during the lost hours of the night without the traveller being roused from his sleeping berth, we shall find that cross-country journeys, those involving changes of train, waiting at stations for connections, will be instantly eclipsed in comfort and speed by aerial travel and aerial mail deliveries. One could suggest Cardiff and Newcastle, or the like.

I do not think that much is to be gained by suggesting routes at the present moment, unless we propose to permit a few machines to be withdrawn from war service, and then, by using a few pilots who are for one reason or another not fit for war service, explore the practical possibilities of such transport I think it far better to start by carrying newspapers and letters, and packets, rather than passengers at first, for every reason The routes will be unknown to the pilots, their experience may perhaps not be great—the advertisement cannot usefully be made in war time, and, generally, it is not desirable, save in exceptional cases, to expend petrol for personal travel, or to expend money in adapting designs to passengers' comfort Yet if this comfort were omitted, a false impression of the facilities to be afforded would easily get spread abroad

I do not know whether certain types, whose performance is below the ever-rising requisites for war could be made available, but I should have thought that with good will they could be managed, and if so, the experiments made in war-time would help us to start *quickly* on declaration of peace, that which might eventually help to create orders—only a few it is true, but still a small fraction of what is wanted for the maintenance of the production factories

Future Speeds

Speed—I am inclined to endorse Mr Holt Thomas's view that, if we consider the average wind speed as 30 miles per hour, sometimes with us and sometimes against, we shall need machines whose own air speed is 120 miles per hour, in the case when there is any competition with other means of transport

On cross-country journeys far lower speeds will be vastly faster than the existing systems, and will at once command attention

As we know, 120 miles per hour is a very ordinary speed today for aircraft, and offers no technical difficulties in alighting—indeed, Captain Green's interesting forecast, under certain conditions which he laid down, of an airplane to travel at 240 miles per hour, did not appear to raise any feeling of doubt or hesitancy at the Aeronautical Society about three weeks ago—though a similar audience in 1911 was very skeptical about the advisability of introducing, even for military purposes, my proposed speed of 72 miles per hour This gives us an idea of the changes which have gone on in men's minds by legitimate extrapolations from the actual achievements with which they are familiar

I have nearly finished, but before doing so I must once more reiterate that the most hopeful estimate for immediate aircraft transport and travel does not save the situation There must be Governmental action to maintain the country's productivity and designing capacity for military and naval aircraft in the first place, and as the mainstay of the country's factory organization

A New Arena

In conclusion, it is only half a truth to say, with Frederick Lait, "the sea is the high street of the earth. The sea is the parade ground of the nations. The sea is the arena for the display of strength and enterprise of all nations." There is now the air. A great instrument of power calculated to peace and usefulness and good will can be designed in a week, if only a British, a French, an American, an Italian plenipotentiary could be empowered to sit around a table. That instrument is the aerial way. Its regulations must not be founded now upon speculations, they must be evolved later upon experience.

All the Allied nations desire the same thing, all are agreed that just as in time of peace we must prepare for the catastrophe of war—so in war we must prepare our thoughts and plans for the cataclysm of peace. The word is used advisedly, for a very sinister situation will develop in the world of aircraft during the hiatus which first was publicly indicated, I think, by myself, in the discussion on Mr Holt Thomas's paper before the Aeronautical Society, and which Lord Cowdray himself promised to make every effort to bridge.

The Continental Pusher Biplane

An interesting type of pusher biplane has recently been produced by the Continental Aircraft Corp., of New York City, to the designs of Louis L. Kaess and Vincent Burnelli. To date, the machine has been in the air for over forty hours and has furnished an all-round satisfactory performance. During the severe cold spell, in the latter part of December, the machine was flown by Bert Acosta from Central Park, L. I., to Amityville, N. Y., over a triangular course of 60 miles, which was covered in 45 minutes at an average altitude of 5000 ft. The thermometer on the dashboard indicated eleven degrees below zero.

THE 110 H.P. TWO-SEATER CONTINENTAL BIPLANE

The Continental pusher biplane has a span of 36 ft., with no overhang, sweepback or transverse dihedral. The overall length is 22 ft. The power is furnished by a 110 hp. Hall Scott engine, model A-5, driving a three-bladed airscrew.

The wing curve is a U. S. A.-5, and the wings have a safety factor of 8, the lift loading being about 7 lb. per sq. ft. The gliding angle of the machine is about 1 in 9.

Among the notable features of the machine is the connection of the tail planes with the wings, which is secured by means of two steel booms. These are inserted in triangular steel frames, covered with cloth to reduce head resistance, which take the place of the inner rear interplane struts. The booms are suitably trussed to the upper and lower wings. The tail planes are of the usual fin-and-flap type, the empennage being non-lifting.

The body is a well stream-lined monocoque construction, which embodies some interesting details, such as the mounting of the engine on heavy veneer panels, which are slotted around the crankcase, and act as engine bearers. A suitable trap door permits the removal of the engine by lowering it to the ground, which dispenses with the necessity of taking down the wings. To complete the stream-line shape of the body, the airscrew is encased into a conical cowl. A starting crank is provided for the convenience of the pilot, who occupies the rear seat, the latter is hinged so that it can be raised when the pilot wants to start the engine.

The control is of the Dep type, with a post taking the place of the yoke. The mountings of the control post and the rudder bar form a unit, with the return pulleys of the elevator wires being mounted on the pedestal of the rudder bar.

The undercarriage is of the two-skid, four-wheel type, and is connected to the body by means of six stream-lined struts. Ackerman wheels, 26 by 4 in. at the rear and 20 by 2½ in. at the front, are mounted on rubber-sprung axles. To slow down the speed of the machine after landing, tusks are provided on the rear end of the skids, these tusks dig up the ground upon negative incidence being given to the elevator flaps, exerting thus an effectual brake force.

The accompanying illustration shows that a great amount of ingeniousness, if not ingenuity, has been expended on this machine with a view of reducing head resistance to a minimum. This object is particularly difficult to achieve on pushers on account of the material parasite resistance offered by the tail outriggers. The designers of the Continental pusher claim that their tail boom construction eliminates about 80 per cent of the resistance generated by the old Curtiss or the Farman type of outriggers, a claim which looks well acceptable in view of the great amount of cross bracing and trussing the said outriggers require. Altogether, the Continental pusher strikes one as a distinctly original design, and one having, on this account, substantial merit.

International Aircraft Standards

(Continued from last issue)

3S34—Specifications for Heat-Treated Alloy Steel Forgings and Stampings

(130,000 Pounds per Square Inch Tensile Strength)

GENERAL.—1. The general specifications, 1G1, shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The steel from which these forgings or stampings are made shall conform to I. A. S. B. specification 385.

MANUFACTURE.—3. *Heat Treatment.*—(a) Forgings or stampings should be annealed before heat treatment.

(b) Forgings or stampings which fail to meet the physical tests may, at the option of the purchaser, be reheat treated.

WORKMANSHIP AND FINISH.—4. (a) The forgings and stampings must be uniform in quality, free from pipes, laps, cracks, twists and seams, and must have a workmanlike finish.

(b) A forging or stamping may be rejected at any time because of injurious defects or faults which are revealed by manufacturing operations notwithstanding that it has previously passed inspection. Such rejected forgings or stampings shall be returned to the manufacturer at his expense. This clause shall not apply to materials fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. (a) The heat-treated forgings or stampings shall have the following physical properties:

Tensile Test.—(b)

	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength	130,000	91 8
Minimum yield point	115,000	80 9
Minimum elongation in 2 inches or proportional gauge length	17 per cent.	
Minimum reduction of area	40 per cent.	

Impact Test.—(c) When impact testing machines of the pendulum type are available, tests shall be carried out if required to determine the specific impact work of rupture in foot-pounds (or kilogram meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

Brinnell Hardness Test.—(d) This test shall be made after the tensile test has been met. The procedure shall be as follows:

(1) Forgings with a Prolongation for Tensile Test Specimens. A hardness test shall be made on the prolong end on the opposite end of the forging. The hardness values obtained must agree within 3 per cent. Hardness values of other forgings in the same lot must agree with the average of the two test values within 3 per cent.

(2) Forgings or Stampings without Prolongations. Hardness tests shall be made on the forgings or stampings selected for the tensile test and must agree within 3 per cent. The hardness values of other forgings or stampings in the same lot must agree with the average of the values so obtained within 3 per cent.

(3) Forgings or Stampings from which a Tensile Test Specimen can not be Procured. A hardness test shall be made on the forged bar representing the forgings or stampings. The hardness values of the forgings or stampings in the lot must agree with that obtained on the bar within 3 per cent.

SELECTION OF TEST SPECIMENS.—6. *Forgings or Stampings Weighing 6 Pounds (3.7 kg.) or over.*—(a) If desired each piece may be required to have a prolongation for the tensile test. Two per cent of the forgings or stampings in each lot shall be subjected to the tensile test unless a tensile test is specified for each forging or stamping.

Forgings or Stampings Weighing Less than 6 Pounds (3.7 kg.) and of Suitable Section for Securing a Tensile Test Specimen.—(b) Two per cent of the forgings or stampings shall be taken for the tensile test.

(c) Forgings or stampings from which no tensile test specimen can be secured shall be represented by a bar forged from the same material and to the ruling section of the forgings or stampings in the lot. The bar must be heat treated with the lot which it represents.

(d) At least one tensile test shall be made for each lot of 50 forgings or stampings.

(e) A hardness test may be required on each forging or stamping offered. At least 25 per cent of the pieces in each lot shall be tested for hardness.

(f) All the forgings or stampings in a lot shall be heat treated at the same time and if possible shall be from the same heat of steel.

DIMENSIONS AND TOLERANCES.—7. The forgings and stampings shall conform to the dimensions on the drawings within the tolerances specified. Surfaces which are to be machined shall admit of finishing to the required dimensions without leaving traces of the original surface.

PACKING, SHIPPING AND DELIVERY.—8. Small forgings or stampings shall be boxed for shipment, the gross weight of individual boxes must not exceed 220 pounds (100 kg.). Each kind and lot of forgings or stampings shall be kept separate as inspected.

3S35—Specifications for Half Hard Carbon Steel Bars and Billets

GENERAL.—1. The general specifications, 1G1 shall form, according to their applicability, a part of these specifications.

MATERIAL.—2. The I. A. S. B. standard steel No. 1045 shall be used, its composition is as follows:

Number	Carbon	Manganese	Phosphorus maximum	Sulphur maximum
1045	0 40–0.50	0.50–0 80	0 045	0.050

When electric or crucible furnace steel is specified in the order, the maximum allowable percentages of phosphorus and sulphur may at the option of the purchaser be limited to 0 03 per cent.

MANUFACTURE.—3. (a) The steel shall be manufactured, or, at least finished by the open hearth, electric furnace, or crucible process.

(b) A sufficient discard shall be made from each ingot to secure freedom from piping and undue segregation.

(c) The billets from which the bars are made are to be rough turned or chipped to remove all surface defects which might produce seams in the finished bar or forging. No undercutting in chipping will be allowed.

Heat Treatment.—(d) The manufacturer shall state the heat treatment recommended to give physical properties specified.

(e) If the bars are delivered in the heat treated condition and the physical tests show that the heat treatment has not been correct the bars may be re-treated at the option of the purchaser.

WORKMANSHIP AND FINISH.—4. (a) The bars are to be sound, commercially straight free from pipes, laps, cracks, twists, seams, voids, and damaged ends and are to have a workmanlike finish. They are to be uniform in quality within the stipulated margins of manufacture, capable of being turned and threaded readily and of taking a good finish.

(b) Any bar may be rejected because of injurious defects or faults in manufacture at any time notwithstanding that it has previously passed inspection; it shall be returned to the manufacturer at the latter's expense. This clause shall not be taken to apply to material fabricated after export.

PHYSICAL PROPERTIES AND TESTS.—5. (a) The bars shall have the following physical properties:

Tensile Test.—(b)

	Pounds per square inch	Kilograms per square millimeter
Minimum tensile strength	95,000	66 8
Minimum yield point	70,000	49 2
Minimum elongation in 2 inches or proportional gauge length	18 per cent.	
Minimum reduction of area	45 per cent.	

Impact Test.—(c) In all cases when impact testing machines of the pendulum type are available, tests may be carried out to determine the specific impact work of rupture in foot pounds (or kilogram meters). Results markedly lower than the average for this type of material will be sufficient cause for further investigation (or reheat treatment) of the material.

SELECTION OF TEST SPECIMENS.—6. Three bars of each size rolled from a heat shall be taken and test pieces prepared in accordance with the I. A. S. B. standards. Each test piece and the bar from which it is cut shall be stamped with an identifying number. Should any of the test pieces, after being heat treated in the manner recommended by the steel manufacturer fail to show the prescribed physical properties, new test pieces similarly identified shall be made from the same three bars. At the option of the purchaser the steel manufacturer may prescribe a different heat treatment for the second set of test specimens, and to this end he may make such tests as he desires from the remainder of the three bars taken for the tests. Should either of the three specimens taken for the final tests fail to show the required physical properties, the bars of that heat of steel represented by the specimens shall be rejected. Where bars are purchased in the heat treated condition, test specimens shall be cut from the heat treated bars.

DIMENSIONS AND TOLERANCES.—7. The dimensions and tolerances shall be those given in the specification 3S11.

DELIVERY, PACKING, AND SHIPPING.—8. (a) The bars may be delivered in the annealed or in the heat treated condition.

(b) The bars shall in general be grouped in bundles weighing not more than 220 pounds (100 kg.), unless otherwise agreed between manufacturer and purchaser. The heat and the I. A. S. B. steel serial numbers shall be plainly marked on a metal tag attached to each bundle. If bars are not so grouped and bundled, each bar shall be plainly marked with the heat number and the I. A. S. B. steel serial number.

Digest of the Foreign Aeronautical Press

The Aeroplane (London), December 26, 1917

Royal Aircraft Factory Test Report on 230 Horsepower Benz Engine.—The Royal Aircraft publishes the following test report on the 230 hp. Benz engine (the salient features of which were summarized in the preceding issue of AVIATION AND AERONAUTICAL ENGINEERING). During the testing the engine was run up to 1700 r p m., the peak of the power curve occurring at 1650 r p m., at which 250 hp. was developed.

The maximum brake m e p reached 119 lbs. per sq. in. at 1100 r p m.

The results of a one-hour test were as follows:

R.P.M.	1400
B.H.P.	220
Petrol consumption	150 pints
Oil consumption	4 5 pints
Water inlet temperature (average)	62 C
Water outlet temperature (average)	71 C
Oil temperature (max.)	50 C (steady)
Oil pressure (min.)	28 lbs. sq. in.—steady

The engine was erected on a test bed and coupled to a Heenan and Froude Water Dynamometer.

After preliminary running, during which the Exhaust Manifold broke and was replaced by one from a similar engine, the accompanying power, throttle and consumption curves were obtained.

CONSTRUCTION DATA

Numbers and arrangement of cylinders	6 vertical
Bore	145 mm. (5 71 in.)
Stroke	190 mm. (7 48 in.)
Stroke bore ratio	1 31 1
Stroke volume of one cylinder	3137 476 cu. cms. (191 386 cu. in.)
Total stroke volume of engine	18824 856 cu. cms. (1148-318 cu. in.)
Area of one piston	165 13 sq. cms. (25 59 sq. in.)
Total piston area of engine	990 78 sq. cms. (153 57 sq. in.)
Clearance volume of one cylinder	796 cu. cms. (48 66 cu. in.)
Compression ratio	4 91 1
Normal B H P and speed	230 B H P at 1400 r p m
Piston speed	1744 ft. per min.
Brake mean effective pressure	113 lb. per sq. in. at 1400 r p m. 119 lb. per sq. in. at 1100 r p m.
Cu. in. of stroke volume per B H P	4 99
Sq. in. of piston area per B H P	667
Hp. per cu. ft. of stroke volume	346 3 hp.
Hp. per sq. ft. of piston area	215 0 hp.
Direction of rotation of crank	R H T
Direction of rotation of propeller	R H T
Normal speed of propeller	Engine speed
Lubrication system	Forced to main bearings from reservoir in sump
Brand of oil	50% vacuum heavy and 50% Sternol
Oil pressure	28 lb. normal, 50 lb. max.
Oil temperature	50° C., max.
Oil consumption per hour	4 5 pints
Oil consumption per B H P hour	02 pints
Specific gravity of oil	9
Type of carbureter	2 Benz, each feeding 3 cylinders (2 jet).
Mixture control	Automatic
Fuel consumption	150 pints
Fuel consumption per B H P hour	65 pints
Specific gravity of fuel	720
Type of magneto	2 Bosch Z H 6
Firing sequence of engine	Prop 1-5 3 6 2-4
Number of cylinders	Prop 1-2 3-4 5-6
Speed of magneto	1½ engine speed
Direction of rotation of magneto facing driving end of armature	Anti clockwise
Magneto timing	30° E mm on stroke
Inlet valve opens, deg. on crank	10° E.
Inlet valve closes, deg. on crank	55° L.
Maximum lift of inlet valve = h	11 8 mm. (465 in.)
Diameter of inlet valve = d (smallest diam.)	Two of 52 mm.
Area of inlet valve ports = $\pi \times d \times h$	19 27 sq. cms. each
Mean gas velocity through inlet valve	124 ft. per sec.
Clearance of inlet tappet	000 in.
Exhaust valve opens, deg. on crank	60° E.
Exhaust valve closes, deg. on crank	20° L.
Maximum lift of exhaust valve = h	11 25 mm. (443 in.)
Diameter of exhaust valve ports = d (smallest diam.)	Two of 52 mm. dia.
Area of exhaust valve ports = $\pi \times d \times h$	18 37 sq. cms. (each) = 2 84 sq. in.
Clearance of exhaust tappet	015 in.
Direction of rotation of revolution counter drive, facing driving shaft in engine	Anti-clockwise
Speed of revolution counter drive	½ E S
Weight of engine complete, with propeller hub, less water, fuel, and oil and exhaust manifold	848 32 lb.
Weight per B.H.P. ditto	3 68 lb.
Weight of exhaust manifold	15 lb.
Weight of oil carried in engine	18 lb.
Jacket capacity of one cylinder	1873 c c
Weight of water carried in engine	40 9 lb.
Weight of radiators, less water	136 lb.
Weight of fuel per hour	135 lb.
Weight of oil per hour	5 06 lb.
Total weight of fuel and oil per hour	140 00 lb.
Gross weight of engine in running order, less fuel and oil. Cooling system at 0 65 lbs. per B H P	996 lb.
Weight per B H P ditto	4 33 lb.
Gross weight of engine in running order, with fuel and oil for six hours (Tankage reckoned at 10% weight of fuel and oil)	1920 89 lb.
Weight per B H P., with fuel and oil for six hours	8 35 lb.

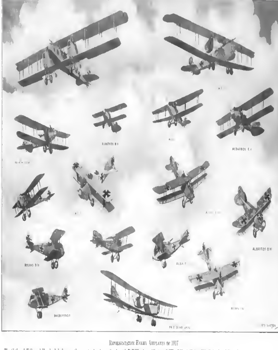
Aeronautics, January 2, 1918

The Airship in Peace.—By JHADOS JAKAZ.—The outstanding characteristic of airships is the enormous lift that can be obtained and the rapidity with which the lift goes up with comparatively small increase in dimensions. It is no secret that the Zeppelin of today has a disposable lift of at least 25 tons. By "disposable lift" is meant the amount available for all movable weights such as crew, fuel and merchandise, after deducting the fixed weights of the framework, gasbags, power units, etc.

Now we were recently told that the largest airplane at present in existence (the Handley-Page) has a disposable lift of about 3 tons, so the disparity between the two is at once apparent.

Stupendous as these figures are, it must be borne in mind that the airship is as yet only in the very early stages of development compared with the airplane, and that even during the war the relationship between the disposable lift and the gross lift of rigid airships has increased from about 25 per cent to over 40 per cent; and there is no reason to suppose that great strides cannot yet be made even with the present methods of construction, which involve an enormous amount of unnecessary weight when considered from the engineering standpoint.

A modern Zeppelin, if used for carrying merchandise, would require a crew of about twenty men, weighing in the aggregate 3,600 lb. It would carry about 4,000 lb. of water ballast, enabling it to attain a height of 1,000 ft., and would therefore have rather more than 23 tons available for fuel and cargo. With five engines giving 1,200 total horse-power the petrol



Representative Enemy Airplanes of 1917

The Gotha, A E G and Friedrichshafen are three-seater bombers, the Aviatik D F W, Ago, Albatros C III, C V, A E G C IV, Roland and Rumpler are two-seater scouts, the Albatros D I, D III, F F, Fokker, Halberstadt and Roland D II are one-man fighters.

Courtesy of *The Aeroplane*

consumption would be about 600 lb per hour If it were employed upon an aerial route 1,000 miles in length at a speed of 50 miles per hour the total weight of petrol to be carried would be 12,000 lb or let us say 6 tons to allow a margin for safety On a journey of this length, then, the airship could carry over 17 tons of goods, or 146 passengers with 100 lb of luggage each

This gives some idea of the capacities of these craft from the purely utilitarian point of view of the amount of weight that can be carried, but there are many other reasons for claiming that airships cannot be summarily dismissed from consideration as commercial vehicles.

Another great argument in favor of the airship as a passenger carrying vehicle rests upon its ability to remain in the air even in the event of complete failure of the power plant It is true, of course that in such circumstances it will be at the mercy of the wind and drift out of its course, but at the same time there will be no necessity to jeopardize the lives of the passengers and the safety of a valuable cargo by making an immediate descent whatever may be the nature of the ground or sea beneath This applies particularly to journeys at night or in fog, when the risks of engine failure in airplane are almost a nightmare

To avoid the perils consequent upon engine breakdowns, heavier-than-air craft will be compelled to fly at a height of at least 4,000 or 5,000 ft, whereas the airship pilot can cruise, and in fact prefers to do so, at any height from 1,000 ft. downwards This adds enormously to the comfort and pleasure of passengers, who can enjoy a view of the landscape as it passes almost on a level with their eyes, instead of seeing, as they would from a height, a flat expanse of greens and browns, with none of that detail which makes the country pleasing to the eye

A small non rigid of the "S.S." type would, one imagines, make an ideal pleasure craft for a wealthy man Costing probably no more than a small yacht, the owner would be able to take himself and a friend, with a mechanic to look after the engine, on short pleasure cruises of eight to ten hours' duration A journey to Paris, for instance, could be undertaken with the utmost ease and comfort, while there seems no reason why in the future such small craft should not be capable of being moored out in the open, for a short period at any rate

After a certain size is reached the non rigid becomes impracticable, owing to difficulties in designing the rigging in such a way as to distribute the weights evenly over the envelope, and in this connection it is curious to note the almost universal neglect of the semi rigid type, except in Italy

Without going into details, there are many reasons for thinking that the ideal type of airship for a passenger-carrying service over a short journey say, from London to Paris, will be found to be a semi-rigid, probably on the lines of the Forlanini, with a capacity of some half million cubic feet.

Flying (London), January 2, 1918

The Development of German Aircraft—The year of 1916 saw the inception of several small scouting biplanes approximating in general outline and characteristics to the various machines of this class used by the Allies This type formed a drastic departure from customary German practice, and was undoubtedly introduced to meet the exceptional demands of air fighting. Those new scouts were engined with either Mercédès, Argus or Benz motors of 160 to 175 hp While contemporary German practice was devoted to the type with swept back wings and pronounced dihedral, these had straight wings of 30 ft span and under, the upper plane was staggered forward, and they were also of the single-seater variety The armament consisted of two fixed machine guns, firing through the propeller

The chief improvements made on German airplanes during 1917 have been the perfecting of the small scout biplane, the gradual substitution of the six-cylinder 260 hp Mercédès for the 240 hp eight-cylinder model, and the production of big, twin-engined bombers of the Gotha, A E G, or Friedrichshafen class During the latter part of 1917, a small, high speed triplane scout has also appeared, and this may be taken as the German version of the highly successful Sopwith triplane

Seaplane design and construction has not advanced to the same level as that of the land machine, the existing examples being mainly copies of pre-war British products. At least two examples of successful British seaplanes were in Germany before the war—a Sopwith bat-boat and a Wight seaplane, both fitted with 200 hp Salmson motors. The machines produced intermittently since that period have all shown decided British influence, two types being very reminiscent of the Sopwith bat-boat and the Avro 100 hp Gnome seaplane.

The average speed of German aircraft in August, 1914, was 70 m.p.h., the time taken for a climb of 3000 ft varying from 5 to 15 mins It appears from data available at that time that the fastest machine was the Halberstadt "Taube," 100 hp Mercédès, with a speed of 92 m p h The next best was the D F W, with 120 hp Austro-Daimler engine, this accomplishing 85 m.p.h It should be noted that a British machine of that period easily excelled these figures Modern two-seater machines of enemy design, with engines of from 225 to 260 hp, are credited with speeds of 100 to 120 m p h. and a climb varying from 6000 to 7000 ft in 9 mins. The pursuit or scouting type of machine equipped with the 175 hp Mercédès engine has a speed of 110 to 125 m p.h, but it should be remembered that ceaseless experimenting and the natural course of evolution is certain to produce improvements It is impermissible to indicate the present performance of Allied aircraft, but it is already more than certain that the arrival of the right time will enable an account of unparalleled achievement to be recorded

Flying (London), Dec. 5, 1917

Standardization of Petrol Gauze—Considerable trouble and delay has been experienced in obtaining a regular supply of petrol gauze, primarily due to the fact that aircraft contractors depended upon importation for the finer mesh required for this very important accessory of aeronautical engines, and it was found that a wide variety of mesh was called for by different manufacturers, although they required the mesh for similar purposes, and in some cases it was very difficult to justify distinction For instance, the difference in the width of the aperture between 200-mesh gauze and 180-mesh gauze is only 1/10,000 of an inch

There has been a tendency to call for meshes much finer than are justified by the conditions This has resulted in the use of a gauze which is much more fragile than is necessary or desirable

To overcome this difficulty the Air Board took the leading manufacturers of wire-cloth into consultation, and the Royal Aircraft Factory experts made certain experiments which have resulted in a standardized gauze being agreed upon

This will greatly facilitate manufacture, and will enable the material to be produced in Great Britain in adequate quantities to meet the demands from aircraft factories The gauze will be known as "Air Board Standard Petrol Gauze."

Aeronautics (London), Dec 12, 1917

Airship Crosses Mediterranean Sea—In the light of future developments it is interesting to record that the Mediterranean in its full width has for the first time been traversed by an airship It may be remembered that a previous crossing by airplane was made by Roland Garros, who on a Morane monoplane flew from Saint-Raphael to the African coast, passing over Corsica and Sardinia, on Dec 18, 1912. On the present occasion the airship, a French one, left Paris and alighted at Aubagne, near Marseilles, continuing its journey thence it crossed the Mediterranean and landed safely at Algiers after a journey which occupied eleven hours. It is known that the French Government intends to establish a regular passenger service by airship between Paris and Algiers after the war The present flight was evidently made in order to demonstrate the feasibility of the scheme, and its success augurs well for the future

The Aeronautical Journal (London), Oct.-Dec., 1917

Commercial Aeronautics By G Holt Thomas—A highly interesting anticipation of the possibilities of commercial aircraft in relation to the transit of passengers, mails and goods.

A Further Three Years' Flying Experience By Captain B C Hucks.—A review of the development of the airplane in three years of warfare

The Training of Aeronautical Engineers By R M Walmsley, D.Sc., F R S E and C E Larard, M I C E, M I M E—An outline of a proposed course of instruction for aeronautical engineers

News of the Fortnight

Surveyor General of Supplies Appointed

The Secretary of War announced on Jan 25 the appointment of Mr Edward M. Stettinius to the post of Surveyor General of Supplies in the office of the Director of Purchases. The latter office was created by General Orders No. 5, of the War Department, dated Jan 11, Col. Palmer E. Pierce of the General Staff of the Army being appointed Director of Purchases and detailed as an assistant to the Chief of Staff.

Four sections have been organized in the office of the Director of Purchases, namely:

Section of supplies, over which Mr. Stettinius the Surveyor General will preside.

The information and statistical section, with Dr Leonard P. Ayres in charge.

The fiscal section, with Dr Milo R Maltbie at its head.

Section on organization and methods, with R R Montgomery in charge.

The Director of Purchases has the following assistants on his personal staff: W. F. Willoughby, Col George E. Estes, General Staff, Maj. Guy Kent, General Staff.

Lieut. Col. Douglas I. McKay has been named as assistant to the Director of Purchases.

The British Air Council

The British Air Council colloquially known as the Air Ministry, which was created by the Air Force Act, 1917 with the simultaneous unification of the British Air Services, has been established on Jan 2 by Order in Council. The Air Council consists of a president and nine members, and is patterned after the general lines of the Board of Admiralty.

The Council is constituted as follows:

Lord Rothermere, Secretary of State and President of the Council.

Major General Sir H. Trenchard, K. C. B., D. S. O., Chief of the Air Staff.

Rear Admiral Mark Kerr, C. B., R. N., Deputy-Chief of the Air Staff.

Commodore Godfrey Paine, C. B., M. V. O., R. N., Master-General of Personnel.

Major General W. S. Brancker, D. S. O., Controller-General of Equipment.

Sir William Weir, Director General of Aircraft Production in the Ministry of Munitions.

Sir John Hunter, K. B. E., Administrator of Works and Buildings.

Major J. L. Baird, C. M. G., D. S. O., M. P., Parliamentary Under Secretary of State.

Lieutenant General Sir David Henderson, K. C. B., D. S. O., Additional Member of Council and Vice-President.

W. A. Robinson, C. B., has been appointed to act temporarily as secretary to the Council and H. W. McAnally to act as assistant secretary.

President Forbids Aircraft Expositions

By the President of the United States of America

A PROCLAMATION

Whereas a state of war exists, and the military and naval forces of the United States are endangered by enemy aircraft, and

Whereas this danger will be increased by communicating to the enemy the present state of aircraft invention in the United States, and

Whereas the holding of so-called expositions of aircraft is a method of collecting and distributing information important to the enemy,

Now therefore I, Woodrow Wilson, President of the United States, by virtue of the authority vested in me by the Constitution and the laws of the United States, do hereby, for the protection of such forces, proclaim to all whom it may concern that, under the pains and penalties prescribed by the laws of war and the statutes of the United States, throughout the present war no exposition of aircraft shall be held in the United States or its possessions.

In witness thereof I have hereunto set my hand and caused the seal of the United States to be affixed.

Done in the District of Columbia this 1st day of January, in the year of our Lord 1918, and of the independence of the United States the 142d.

WOODROW WILSON

Fire Insurance for Aircraft

As a result of an inquiry conducted by the National Advisory Committee for Aeronautics into the subject of fire insurance for aircraft, it is found that most of the fire insurance companies are not writing or contemplating insurance for aircraft.

One large fire insurance company has announced that it is now prepared to issue such insurance. It appears, therefore, that other companies will take similar action, and that before long such insurance may be written generally.

Briefly, the new form of policy covers airplanes and seaplanes against fire arising from any cause while in flight or upon the earth, or upon any lake or river, or in or over the coastal waters of the United States, excluding Alaska, Porto Rico, etc. It will also cover the shipment of aircraft upon any railroad or other conveyance within the limits of the policy against burning, sinking, derailment or collision of the conveyance.

This insurance company advises caution in erecting buildings and to avoid the congestion of hangars, which are usually remote from fire protection, and sometimes built close together; they should be separated by proper distances to the end that the burning of more than one hangar may be avoided. The separation of the units will also allow time for the removal of aircraft from endangered hangars.

Large Plant Runs with Auto Motors

A complete shutdown of the plant of the Dayton Metal Products Co and a vital loss in the production of turnbuckles and turnbuckle rods for fighting planes was recently avoided by the foresight and ingenuity of Secretary Hilton.

Several large plants in Dayton who are furnished power by the Dayton Light & Power Co were closed Monday, Tuesday and Wednesday, Jan. 14, 15 and 16, because the power company was out of coal.

Hearing Saturday night that a forced shutdown was imminent, Hilton gave orders to remove from the company's trucks and passenger cars all the motors that could be spared. Seven motors were requisitioned. Six were installed at strategic points in the plant, while the seventh was held in reserve. The work was done Sunday and Sunday night by a force of garage men, carpenters and plumbers. Large gasoline tanks were also mounted.

On Monday morning with belts connected to main drives the automobile motors, with the help of a Fairbanks & Morse stationary gas engine, started to deliver the necessary power to keep the automatic machines going at full speed, and no loss in production resulted during the three days.

To run the plating department a Delco Light engine was installed and run from several units of Delco-Light batteries.

The automobile motors used were two Packards, two old Speedwells, one Sevelinder Detroiter and an Apperson. The old Apperson went to pieces one evening at five, but at six o'clock was replaced by the reserve motor.

Twenty-five oil heaters were also purchased as a preparedness measure. All the extra equipment will be held in reserve until the fuel situation becomes normal.

N. F. C. to Be Increased

A bill has been submitted to be introduced in Congress by Secretary of the Navy Daniels in regard to a temporary increase in the Naval Flying Corps. The bill (H. D. 847), which was referred to the Committee on Naval Affairs asks that the authorized number of enlisted men of the Flying Corps be temporarily increased from 350 to 10,000.

Long Balloon Flight

A balloon carrying five army men from Omaha, Neb., landed at Sarrell, Minn., making it was declared on Jan. 4, a new army record for time and distance.

The balloon left Fort Omaha at midnight, Jan. 2, and landed at 9:15 o'clock the next day, approximately 450 miles away. Lieutenant McKinley was in charge.

Appointed to Joint Board

Lieut. Col. Thurman H. Bane, Signal Corps, has been appointed a member of the Joint Army and Navy Technical Aircraft Board, vice Maj. Harold S. Martin, Signal Corps.

Death of Edward M. Hagar

Edward McKim Hagar, prominent in business circles in New York and Chicago, and for some time president of the Wright Martin Aircraft Corp., died of pneumonia at his home, 690 Park avenue, New York City, on Friday, Jan 18. Mr Hagar was born in Salem, Mass., on June 21, 1873. In

EDWARD M. HAGAR
Photo by Aulman

1893, when not yet twenty years old, and the youngest member of his class, he was graduated from the Massachusetts Institute of Technology. At the age of twenty one he received his post-graduate degree of doctor of philosophy from Cornell University.

Mr Hagar's first business experience was with a traction company in Chicago. Later he organized and conducted the business of Edward M. Hagar & Co., Chicago, which acted as sales representative for machinery manufacturers. A few years later he resigned in order to accept the managership of the cement department of Illinois Steel Co., Chicago. His rise was rapid, and when this company was absorbed by the United States Steel Corporation, Mr Hagar was made manager of the Universal Portland Cement Co., the largest shippers of cement in the world.

He continued in the cement business until 1914, when the outbreak of the war impressed him with the tremendous possibilities of the airplane. In March, 1916, he was elected president of the Wright-Martin Aircraft Corporation, which was incorporated under the laws of New York, with a capital of more than $5,000,000. This company was a consolidation of the Wright Aeroplane Company, the Glenn L. Martin Aeroplane Company, the Simplex Automobile Company, the General Aeronautic Company, and the Empire Foundry Company.

In May, 1917, Mr Hagar resigned to become president of the American International Steel Corporation, a subsidiary of the American International Corporation, which has offices at 120 Broadway, New York City; he was identified with this concern at the time of his death.

Mr Hagar was a member of many clubs, including the Chicago, Union League, University, Onwentsia, Chicago and New York Yacht Clubs, Racess, Riding, Engineers' Club of New York, and the Technology Club of New York, of which he was vice-president. He is survived by his widow.

Bragg Wins Curtiss Trophy

The Contest Committee of the Aero Club of America has awarded the Curtiss Marine Flying Trophy for 1917 to Caleb S. Bragg. Before he entered the competition he had promised, in case he won, to give the $1,000 in prize money to American aviators.

Mr Bragg was asked by the Liberty Loan Committee of New York City to fly to Troy and distribute Liberty Loan literature on the way. The trip was made on Oct. 26, 1917, with Philip Beyer as passenger, from Port Washington, L. I. The machine used was a Wright-Martin seaplane.

The Curtiss trophy is valued at $5,000, and with it goes $5,000, to be divided equally into five annual prizes. It was first won in 1915 by Major Oscar A. Brindley, flying between San Diego and San Juan, California. In 1916 the trophy was won by Victor Carlstrom over a course from Newport News to Fisherman's Point, Va.

Sorenson With Curtiss

Clarence Sorenson, formerly of La Crosse, Wis., on Jan. 1 became assistant general superintendent of the Curtiss Aeroplane Co's new factory, according to an announcement. Mr Sorenson will have under him fifteen superintendents.

Accessory Manufacturers Meet at Dayton

Business men do not usually expect to be entertained individually or in a body by large companies whose business they are soliciting. Nor do they expect to be taken through a large airplane plant and shown all the vital manufacturing processes. They are rather more accustomed to looking at the inside from without than the reverse. However, about seventy airplane accessory manufacturers had this novel experience recently.

The Dayton Wright Airplane Co. gave a dinner on Jan 18 at the Dayton City Club to airplane accessory manufacturers of contiguous territory. Officers of the company also gave practically the whole day to entertaining their guests, whose welfare was looked after down to the details of railroad and Pullman tickets, hotel accommodations and automobiles for the twelve mile ride to the airplane factories, hangars and back to town.

One manufacturer who at first had not grasped the underlying idea of the affair, said: "While I am curious, I am not quite sold on this. Here we are a big bunch of outsiders invading a busy plant, working on the most vital feature of our war plans, wasting the time of officials and employees, and, in a good many cases, wasting our own time."

After the trip through the plants, dinner and speeches, this same individual expressed his new religion to a representative of AVIATION AND AERONAUTICAL ENGINEERING fervently and with no suggestion of other stimulation than the spirit of the meeting (in deference to visiting uniforms, it was a temperance affair). Said the convert: "I want to tell you, I have gotten something out of today. I have gotten this: I appreciate better the fundamental difficulties of airplane production. After listening to talks by Captain Hannay, R. F. C., Mr Talbot, Major Vincent and Mr Kettering, I have a pretty good mental picture of the whole proposition, on the physical side, actual inspection of a completed fighting machine and its manufacturing processes, and on the other, the man's part I must play as a manufacturer of an essential accessory, turning it out from the best materials, through the most exact workmanship, and just one jump ahead of 'faster than hell.'

"I know now where to go for information, and I know that I will get it if I go there.

"I know that it is up to me not to lay back and holler if a change in design is suddenly sprung on me, or if there is only one blueprint for a job that requires twenty. I know that the war is changing daily, that airplanes are still in a state of evolution, and that I can personally see to make a tracing and additional prints if they are needed.

"I appreciate that there will be no alibi for slow production in this war. We will either have to make good on American

manufacturing methods or admit that Fritz is a better man. Nor can we pass the buck to the officers of the Aviation Section. The very immensity of the job of organization, or building up production from nothing, of getting a powerful engine, I now see is the main cause for such mistakes and delays as have occurred.

"The remarkable thing is that an organization which has had to expand 1000 per cent since we got into the war has made good to such a creditable extent.

"In other words, I am going back to my plant with a fresh reserve of that American commercial pep which ought to work just as successfully in putting over this war job as it has in building up the industries of my state"

To the visiting manufacturers unacquainted with Dayton methods the hospitality of the Dayton Wright company and the many courtesies extended came as a revelation. They felt that new vitality had been given to the much abused terms, "cooperation and coordination." They left Dayton with definite knowledge of just how to weave those terms into a working day formula.

Major J G Vincent's talk at the dinner dealt with the development of airplane engines and the necessity of this country producing a high powered engine which could be turned out in great quantities by American machine methods. He laid at rest persistent rumors as to the failure of the Liberty engine. AVIATION AND AERONAUTICAL ENGINEERING is in a position to emphasize and confirm the splendid performance records of this engine, and the fact that a steadily mounting number of complete engines are being turned out each week. The censorship does not permit of details being published of the first successful combined reconnaissance, combat and day bombing machine which is now in production.

Major Vincent told in detail just how the Liberty job had been accomplished. He told modestly, though convincingly, of his very important part in this work. He treated the entire matter as an engineering and manufacturing problem that had to be solved, and solved quickly. In plain, moreale language he told the technical story and how, through splendid cooperation, hard continuous work, and good luck, success had been achieved. He told, in another way, the story which, several months ago, was first told in exultant and overdrawn sentences, with the result that the sceptics, grown suspicious of official publicity remained unconvinced. But none of the audience who heard Major Vincent's talk, who had seen the big Twelve in a fighting machine, and who had talked to aviators and mechanicians, remained unconvinced.

C F Kettering, vice-president of the Dayton Wright company, visualized for his audience the practical requirements for a successful airplane, how the fighting machine which his company was building had been adapted from foreign designs for the Liberty engine and to American quantity production methods, and the necessity for the accessory people to realize the vital part they must play. Kettering has a gift for presenting things forcefully, crisply and humorously. He knew his subject and his talk made a lasting impression, as it came from a man who is respected first for his ability as a production engineer.

The confidence inspired by knowledge on the aviator's part of the good workmanship and materials in his plane was the subject of a talk by Captain Hannay, R F C. He added the weight of his expert opinion as to the effectiveness of the Liberty engine and the excellent performance of the Combat machine, the first of which are being now produced, and which will later, he hoped, form a large part of our aerial effectives at the front. Captain Hannay's attitude was one of polite credulity as to what we were to do in the future, but he asked very earnestly that we do something quickly.

Orville Wright was expected, but was unable to attend, as the old injury to his leg was again giving trouble. The purposes of the gathering were explained by H E Talbot, Jr, president of the Dayton-Wright company, who also acted as toastmaster in introducing the speakers.

Those who attended follow.

At speakers' table were seated H E Talbott, Jr, President, The Dayton Wright Airplane Co, Captain Hannay, Royal Flying Corps, C F Kettering, Consulting Engineer, The Dayton Wright Airplane Co, Major Vincent, U. S. Signal Corps, Frederick Patterson, Vice-President The National Cash Register Co, H M Estabrook, President The Barney & Smith Car Co, G M Williams, Assistant to President The Dayton Wright Airplane Co, A B Hilton, Dayton Metal Products Co, Thomas P Gaddis, Secretary, The Dayton Wright Airplane Co, R O Gill, Factory Manager, The Dayton Wright Airplane Co., J M Schoonmaker, Jr., Chief Engineer, The Dayton Wright Airplane Co.

The following guests were in attendance: J C Widman, J. C. Widman Co, Detroit, Mich., Chas. Widman, J C Widman Co, Detroit, Mich, J N Roberts, J N Roberts Co., New Albany, Ind, A D Wilt, Jr, Schweppe & Wilt Mfg. Co, Detroit, Mich, J B Clare, Schweppe & Wilt Mfg. Co, Detroit, Mich, F A. Chapman, Ypsilanti Reed Furniture Co, Ionia, Mich, F R Eaglesfield, Kawneer Mfg Co, Niles, Mich, Mr Preston, Goodyear Tire & Rubber Co., Akron, Ohio, Mr Russon, Goodyear Tire & Rubber Co, Akron, Ohio, Griswold Wilson, General Rubber Goods Co, Cleveland, Ohio, L. H. Wallace, General Rubber Goods Co, Cleveland, Ohio, A. J Jupp, The Lunkenheimer Co, Cincinnati, Ohio, M L Mitchell, The Robt. Mitchell Furniture Co., Cincinnati, Ohio.

J A Aull, The Lunkenheimer Co, Cincinnati, Ohio, L. E. Bauer, Dayton, Ohio, C L West, West Wood Working Co, Chicago, Ill, W L Batt, Hess Bright Mfg Co, Philadelphia, Pa., W F Palmer, National Screw & Tack Co, Cleveland, Ohio, R P Troxell, W H Hoover Co, New Berlin, Ohio, C. W. Dickinson, General Fireproofing Co, Youngstown, Ohio, Mr Ahlbrandt, American Rolling Mills, Middletown, Ohio, Mr Duggan, Aluminum Co of America, Cleveland, Ohio, J Lloyd, Phillips Sheet & Tin Plate Co, Merton, W Va., W P Taylor, Lewis Spring & Axle Co, Chelsea, Mich, A. N Wilcox, Dayton Wire Wheel Co, Dayton, Ohio, R E Chagan, Hess Bright Mfg Co, Philadelphia, Pa., W R Brewer, Kellog Switchboard & Supply Co, Chicago, Ill, H W Adams, Jr, Scovill Mfg Co, Waterbury, Conn.; I J Mandel, National Lock Co, Rockford, Ill.

Geo Newbold, AVIATION AND AERONAUTICAL ENGINEERING, New York, J M Howett, Brightman Mfg Co, Columbus, Ohio, J T Annas, Western Automatic Machine Screw Co, Elyria, Ohio, R Oldfield, Western Automatic Machine Screw Co, Elyria, Ohio, J T Bowlus, Ridgley Trimmer Co, Springfield Ohio, Mr Williams, Ridgley Trimmer Co, Springfield, Ohio, C C Koontz, Union City Body Co, Union City, Ind., C C Attlespurger, Sedan Body Co, Union City, Ind, Mr Cheyney, Aluminum Co of America, Cleveland, Ohio, Mr Varney, Aluminum Co. of America, Pittsburg, Pa, J. C Turner, J C Turner Novelty Co, Dayton, Ohio, Bruce Ott, Maxwell Motor Co, Dayton, Ohio, J C Peil, Maxwell Motor Co, Dayton, Ohio, R B Dutch, Troy Mfg Co, Troy, Ohio, C C Cross, Troy Mfg Co, Troy, Ohio, R R Root, Globe Machine & Stamping Co, Cleveland, Ohio, Mr Drosche, Turner Novelty Co, Dayton, Ohio, Wm Kern, Turner Novelty Co, Dayton, Ohio.

F W Eggers, Eggers Veneer Seating Co, Two Rivers, Wis., G S Hamilton, Hamilton Mfg Co, Two Rivers, Wis., A. J Clampitt, Hamilton Mfg Co, Two Rivers, Wis., R. R. Newell, J A Roebling Sons Co, Cleveland, Ohio, Carl Lev, Columbia Steel Shafting Co, Pittsburg, Pa, E J Ickes, Columbia Steel Shafting Co, Pittsburg, Pa., H G Carnell, National Cash Register Co, Dayton, Ohio, M E Service, National Cash Register Co, Dayton, Ohio, J H Frankmer, National Cash Register Co, Dayton Ohio, F A McGee, Baldwin Co, Cincinnati, Ohio, Mr Hockley, Packard Agency, Dayton, Ohio, W F Thoma, Indiana Lamp Co, Connersville, Ind, Frank Ansted, Indiana Lamp Co, Connersville, Ind, F A Durnell, Keyless Lock Co, Indianapolis, Ind, Fred Gennett, Star Piano Co, Richmond, Ind, Harry Gennett, Star Piano Co, Richmond, Ind, Mr Frost, Superior Steel Corp., Pittsburg, Pa, W H Kohler, J A Fay & Egan Co, Cincinnati, Ohio, Captain Newman, U S Signal Corps, Houston Lowe, Lowe Bros. Co, Dayton, Ohio, B L Lotz, Lowe Bros. Co, Dayton, Ohio; J M. Graham, Lowe Bros Co, Dayton, Ohio.

The following, connected with The Dayton Wright Airplane Co, were also present at the banquet and acted as guides during the tour of inspection: C J Sherer, H A Fitzjohn, R H Turner, H K Hamilton, C H Gosiger, O. F Schmidt, H. S Mathers, H P Wardwell, F. A. Ford, J L. Prammer, A P Smith, E Darrow, L. C Luncke, H F Wygant and B. M. Shofstall.

The executive officers of The Dayton Wright Airplane Co are: H E Talbott, chairman board of directors, H E Talbott, Jr, president, G M Williams, assistant to president; C F Kettering, consulting engineer, R O Gill, factory manager, and J. M Schoonmaker, Jr, chief engineer.

February 1, 1918

Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of all companies listed below. Names of Advertisers in this issue are printed in heavy face type.

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California Aviation Co.
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Dewey Aeroplane Co.
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Flint Aircraft Co.
Fowler Airplane Corp.
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McAdamite-Aluminum Co.
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United Smelting & Aluminum Co.

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Moler Aviation Instructors
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Whitman & Barnes Mfg Co
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